



# Dunedin 3 Waters Strategy

Port Chalmers  
Integrated Catchment  
Management Plan





# Port Chalmers Integrated Catchment Management Plan 2010-2060

## Contract No. 3206 Dunedin 3 Waters Strategy



URS New Zealand  
31 Orchard Road  
Christchurch  
New Zealand

Telephone: +64 3 374 8500  
Facsimile: +64 3 377 0655

Opus International Consultants Limited  
Environmental  
Opus House  
20 Moorhouse Avenue  
Christchurch  
New Zealand

Telephone: +64 3 363 5400  
Facsimile: +64 3 365 7858  
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A handwritten signature in blue ink, appearing to read 'D. Stevens'.

Approved for Release:

**Dan Stevens**  
Principal, Opus International Consultants Ltd

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### Executive Summary

The Port Chalmers Integrated Catchment Management Plan 2010-2060 (ICMP) is one of ten long term ICMPs developed as part of the 3 Waters Strategy recently undertaken by Dunedin City Council (DCC).

In 2007, short term stormwater discharge consents were granted by the Otago Regional Council (ORC) permitting stormwater discharges into the Otago harbour pending the development of stormwater catchment management plans. The emphasis of such plans is on monitoring stormwater quality and mitigating stormwater effects on the harbour's receiving environment.

Strategic objectives of stormwater management provide the overarching objectives that guide the development of this ICMP. These objectives are at the core of the relevant statutory and non-statutory documents addressing stormwater management, including the 3 Waters Strategic Direction Statement. These objectives have been developed with the aim of achieving benefits across the four 'wellbeings' (environmental, social, economic and cultural), within the context of a 50 year timeframe, and cover the following:

- Development;
- Levels of service;
- Environmental outcomes;
- Tangata whenua values;
- Natural hazards; and
- Affordability.

The Port Chalmers catchment is relatively small, covering an area of approximately 58 ha, bounded by coastline to the south-west, a rural area of significant bush cover to the north and the Otago port to the north-east. Land use within the catchment is predominantly residential and rural with areas of commercial and industrial land use. There is no natural stream network in this catchment.

The Otago Harbour is the receiving environment for the stormwater discharges from this catchment, with a stormwater outfall discharging to the Lower Harbour to the east of the catchment and two further outfalls discharging to the Upper Harbour to the west of the catchment. The marine receiving environment also receives stormwater and other discharges, at various points throughout the Upper and Lower Harbour. The Upper Harbour is 23 km long and has been heavily modified by reclamation, transport causeways and dredging. There are a number of stormwater and other discharge points into the Upper Harbour, carrying a variety of contaminants however many, including DCC's other stormwater discharges are several kilometres from the Port Chalmers catchment. There are further stormwater inputs to the Lower Harbour from 18 outfalls located around the Port, the consents for which are held by Port Otago Limited.

The harbour is considered an important area for recreation and tourism and is of great significance to Māori and others.

Monitoring of the harbour environment has been carried out annually in accordance with the conditions of resource consent for DCC stormwater discharges. To date four rounds of biological, and stormwater quality monitoring have been undertaken (2007 to 2010) harbour-wide. However, the monitoring of stormwater quality is the only consent requirement for annual monitoring in the Port Chalmers catchment. Variability in monitoring results and small datasets makes it difficult to establish



stormwater quality and identify a link between the stormwater quality and the health of the receiving environment.

A linked 1 and 2-dimensional hydrological and hydraulic model of the Port Chalmers catchment and stormwater network was developed to replicate the stormwater system performance, and to predict flood extents during a number of different land use, storm event and climate change scenarios.

Flow monitoring was undertaken for this catchment and the model partly calibrated to replicate the observed flow, depth and velocity data as well as was possible. Confidence in the model is considered to be low to moderate.

An assessment of environmental effects, based on the interpretation of the outcomes of the stormwater network hydraulic modelling; marine assessments; information gathered during catchment walkovers; DCC flood complaints records; and information gathered during workshops with DCC Network Management and Maintenance staff, identified a number of stormwater related issues.

Stormwater issues were prioritised, and management targets and catchment specific approaches were developed for the Port Chalmers catchment based on each issue, and the strategic objectives for stormwater management. Table ES-1 summarises the key issues, effects, targets and catchment specific approaches for the Port Chalmers catchment.

The prioritisation score assigned to each issue indicates whether active or passive management is required. Active management indicates that DCC will seek to implement changes to stormwater management in the catchment, whereas passive management would tend more towards monitoring and review of existing management practices to ensure that the targets set can be met.

Of all of the issues identified in the catchment, the following were identified as requiring active management:

- Limited Confidence in the Knowledge of Effects on the Otago Harbour Environment and Variability of Stormwater Quality Results

The remaining issues were categorised as requiring passive management. This is predominantly due to the location, short duration, or shallow depth of predicted flooding in the catchment or less than minor adverse effects.

For the majority of the issues identified in this catchment a limited number of management options were available when taking into account the catchment specific approach and targets set. This resulted in recommendation of all options presented, with a priority placed according to issue prioritisation.

Tables ES-2 to ES-4 outline the recommendations, split into further studies, planning and education, and operation and maintenance tasks. The further studies recommended will assist in improving certainty around catchment management targets, or provide further information in order to develop options. Note that where a recommendation is to be resourced internally at DCC, a cost of \$ 0 has been assigned.

The implementation of these recommendations will be determined by the 3 Waters Strategic Plan, which will assess all of the ICMPs developed by DCC, and develop a prioritised programme of works across the city.



Table ES 1: Port Chalmers Catchment Issues, Approach and Targets Summary

| Issue (Problem Description)                                                                                         | Effects Summary                                                                                                                                                                                                                                                                                   | Strategic Objectives and Targets                                                                                                                                                                                                                                                                                                                                                  | Catchment Specific Approach                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | SMART Targets                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results | <p>High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear.</p> <p>Poor information on actual effects of stormwater on harbour environment.</p> <p>Lack of data to assess linkages between pipe discharge and harbour environment quality.</p> | <p>Improve the quality of stormwater discharges to minimise the impact on the environment.</p> <p>Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges.</p> <p>No recorded breaches of the Resource Management Act.</p> <p>Ensure stormwater discharge quality does not deteriorate.</p> | <p><b>Manage Actively</b></p> <p>Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework.</p> <p>Develop method for determining linkages between stormwater management and harbour environment.</p> <p>Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable.</p> <p>Require source control of stormwater contaminants in new development of high-contaminant generating land uses.</p> <p>Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality.</p> <p>Undertake monitoring to ensure stormwater quality does not deteriorate over time.</p> <p>Incorporate a feedback process to the ICMP if / when monitoring indicates potential adverse effects from stormwater discharges.</p> | <p>Robust city-wide monitoring framework developed and implemented by 2012.</p> <p>Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013.</p> <p>Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015.</p> |



| Issue (Problem Description) | Effects Summary                                                                                                                                                                                                                                                                                                                                                                                                           | Strategic Objectives and Targets                                                                                                                                                                                                         | Catchment Specific Approach                                                                                                                                                                                                                                                                                                                  | SMART Targets                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Network Maintenance         | <p>Flooding extents and durations in Port Chalmers catchment are potentially exacerbated by variations in the frequency and standards of catchpit cleaning and maintenance.</p> <p>City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.</p>                                                    | <p>Maintain key levels of service into the future by adapting to climate change and fluctuations in population, while meeting all other objectives.</p> <p>&gt; 60 % residents' satisfaction with the stormwater collection service.</p> | <p><b>Manage Passively</b></p> <p>Ensure consistency city-wide of stormwater structure cleaning and maintenance.</p> <p>Ensure cleaning and maintenance schedules and contracts are sufficiently robust.</p> <p>Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk.</p> | <p>Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide).</p> <p>Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012.</p> <p>Develop list of key stormwater assets in Port Chalmers catchment requiring additional cleaning and maintenance checks by 2013.</p> |
| Nuisance Flooding           | <p>Nuisance flooding is predicted on a regular basis in a number of locations due to limited network capacity and restrictions throughout the catchment. Flooding is not significant during small events but becomes progressively worse with larger events.</p> <p>Affects 0.04 % of catchment area during 1 in 2 yr Average Recurrence Interval (ARI) events, and 0.7 % of catchment during a 1 in 10 yr ARI event.</p> | <p>Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network.</p>                                                                                                                     | <p><b>Manage Passively</b></p> <p>Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances).</p> <p>Undertake pipe renewals programme as scheduled (with older pipes and poorly performing network areas prioritised).</p>                                                              | <p>&lt; 33 % manholes predicted to overflow during a 1 in 10 yr ARI rainfall event by 2060.</p> <p>&lt; 0.7 % of catchment surface predicted to flood during a 1 in 10 yr ARI rainfall event by 2060.</p>                                                                                                                                                     |



| Issue (Problem Description) | Effects Summary                                                                                                                                                                                                                                                                                                                                                                                     | Strategic Objectives and Targets                                                                                                                                                                                                                                                                                                                                                                                                                                  | Catchment Specific Approach                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | SMART Targets                                                                                                                                                           |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Low Level of Service        | <p>General low level of service of stormwater network (less than 1 in 10 yr ARI), driven predominantly by network capacity.</p> <p>33 % of manholes predicted to overflow during a current 1 in 10 yr ARI rainfall event, with pipes flowing full throughout a large proportion of system.</p> <p>This low level of service is currently occurring with no capacity for climate change effects.</p> | <p>Maintain key levels of service into the future by adapting to climate change and fluctuations in population, while meeting all other objectives.</p> <p>Ensure new development provides a 1 in 10 year level of service for stormwater, and avoids habitable floor flooding during a 1 in 50 yr ARI rainfall event.</p> <p>95 % of customer emergency response times met.</p> <p>&gt; 60 % residents' satisfaction with the stormwater collection service.</p> | <p><b>Manage Passively</b></p> <p>Maintain or improve existing level of service in network – ensure no increase in the number of stormwater manholes predicted to overflow in a 1 in 10 yr ARI rainfall event.</p> <p>Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances).</p> <p>Undertake pipe renewals programme as scheduled (with older pipes prioritised).</p> <p>Use customer complaints and residents' opinion survey (ROS) to gauge satisfaction with the stormwater system performance.</p> | <p>&gt; 20 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060.</p> <p>&gt; 60 % residents' satisfaction with the stormwater collection service (ongoing).</p> |



| Issue (Problem Description)                       | Effects Summary                                                                                                                                                                                                                     | Strategic Objectives and Targets                                                                                                                                                                                                                                                                                                                                                      | Catchment Specific Approach                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | SMART Targets                                                                                                                                                                                                                 |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Flood Hazard – Current and Future 1 in 100 yr ARI | <p>Areas of 'moderate' to 'significant' flood hazard in roadways, including State Highway, predicted during current event.</p> <p>'Moderate' to 'significant' flood hazard extent predicted in the future (2060) event.</p>         | Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network.                                                                                                                                                                                                                                                                         | <p><b>Manage Passively</b></p> <p>Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event.</p> <p>Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas.</p> <p>Ensure transport routes around flooding areas will be available.</p> <p>Develop a better understanding of the likely effects and magnitude of climate change.</p> | Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan.                                   |
| Ongoing Stormwater Discharge                      | <p>Could exacerbate existing / historical contaminant issues. Extent to which this is likely to occur is unconfirmed.</p> <p>Key stakeholder issue.</p> <p>Based on available data, consequence currently believed to be minor.</p> | <p>Improve the quality of stormwater discharges to minimise the impact on the environment.</p> <p>Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges.</p> <p>&gt; 75 % compliance with stormwater discharge consents.</p> <p>Ensure stormwater discharge quality does not deteriorate.</p> | <p><b>Manage Passively</b></p> <p>Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable.</p> <p>Require source control of stormwater contaminants in new development of high-contaminant generating land uses.</p> <p>Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality.</p>                                                                                                                                                                                                  | <p>No deterioration of stormwater quality due to land use change or development in the catchment.</p> <p>Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015.</p> |



| Issue (Problem Description)        | Effects Summary                                                                                                                                                                                                                                                                                                                                  | Strategic Objectives and Targets                                                                                                                                                                                                                                                                                                                                                      | Catchment Specific Approach                                                                                                                                                                                                                                                                                                                                                       | SMART Targets                                                                                                                                                                                                                                                                                      |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Potential Wastewater Contamination | High microbial contamination of stormwater in 2007, may be cause for concern.                                                                                                                                                                                                                                                                    | <p>Improve the quality of stormwater discharges to minimise the impact on the environment.</p> <p>Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges.</p> <p>&gt; 75 % compliance with stormwater discharge consents.</p> <p>Ensure stormwater discharge quality does not deteriorate.</p> | <p><b>Manage Passively</b></p> <p>Continued stormwater monitoring to enable better understanding of potential catchment contamination.</p> <p>Investigate potential sources of wastewater contamination.</p> <p>Develop appropriate management options to remediate problem where necessary.</p>                                                                                  | <p>Improve data relating to levels microbial contamination and potential sources of contamination within the catchment by 2012.</p> <p>Implement management options to remediate problem where necessary.</p>                                                                                      |
| Deep Flooding                      | <p>Model results indicate 4 land parcels affected by deep flooding during 1 in 10 yr ARI rainfall event; rises to 9 parcels during 1 in 50 yr ARI rainfall event in current and 12 parcels in future planning scenarios.</p> <p>A proportion of the deep flooding predicted during high frequency events is predicted exterior to buildings.</p> | <p>Ensure new development provides a 1 in 10 year level of service for stormwater, and avoids habitable floor flooding during a 1 in 50 yr ARI rainfall event.</p> <p>Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network.</p>                                                                                               | <p><b>Manage Passively</b></p> <p>Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event.</p> <p>Enhance understanding of effects of deep flooding, particularly on private property.</p> <p>Undertake pipe renewals programme as scheduled (with older pipes prioritised).</p> | <p>&lt; 9 properties at risk of deep flooding (&gt; 300 mm) during a 1 in 50 yr ARI rainfall event by 2060.</p> <p>Undertake habitable floor survey and / or damage assessment of potentially flooded properties.</p> <p>&gt; 20 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060.</p> |



| Issue (Problem Description)    | Effects Summary                                                                                                                | Strategic Objectives and Targets                                                                                                                                                                                                                                                                         | Catchment Specific Approach                                                                                                                                                                                                                                       | SMART Targets                                                                                                                                                                                                                                                                                      |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wastewater Emergency Overflows | Potential for wastewater contamination of stormwater should overflows operate. Analysis to date suggests infrequent operation. | <p>Reduce the number of wastewater overflows arising as a result of capacity.</p> <p>Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges.</p> <p>Ensure stormwater discharge quality does not deteriorate.</p> | <p><b>Manage Passively</b></p> <p>Undertake monitoring to enable better understanding of frequency and cause of operation and risk of potential stormwater contamination.</p> <p>Develop appropriate management options to remediate problem where necessary.</p> | <p>No pump station overflows due to capacity during a 1 in 10 yr ARI rainfall event.</p> <p>Improve understanding of frequency and cause of operation and risk to stormwater quality by 2015.</p> <p>Develop management approaches and ongoing monitoring protocols by 2015 where appropriate.</p> |



**Table ES 2: Further Study Recommendations**

| Risk Matrix Score | Task                                                                                                                                                     | Budget Cost | Work Period  |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|
| 160               | Redesign the city-wide framework for stormwater quality and harbour environment monitoring.                                                              | \$ 20 k     | 3 - 6 months |
| 40                | Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.                               | \$ 0        | Ongoing      |
| 30                | Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI). | \$ 20 k     | 3 - 6 months |

**Table ES 3: Planning and Education Recommendations**

| Risk Matrix Score | Task                                                                                                                                                                              | Budget Cost | Work Period   |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------------|
| 40                | Develop a city-wide climate change adaptation plan, including ongoing monitoring of climate change predictions, incorporating damage assessment of the vulnerable infrastructure. | \$ 0        | 6 - 12 months |
| 40                | Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.                                               | \$ 0        | 2 months      |

**Table ES 4: Operation and Maintenance Recommendations**

| Risk Matrix Score | Task                                                                                                                                                          | Budget Cost | Work Period  |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|
| 160               | Implement the revised city-wide monitoring framework.                                                                                                         | \$ 25 k     | Annual       |
| 50                | Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance. | \$ 20 k     | 3 - 6 months |
| 50                | Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.                              | \$ 20 k     | 2 months     |
| 40                | Ensure planned renewals are designed to accommodate a 1 in 10 yr ARI rainfall event and incorporate allowances for climate change.                            | 0           | Annual       |
| 20                | Implement programme to monitor wastewater emergency overflows.                                                                                                | \$ 25 k     | Annual       |



## Part 1

### Introduction







# 1 Introduction

## 1.1 Background

Dunedin City Council (DCC) is currently in the process of implementing an integrated approach to asset management and a business improvement project in order to meet capital and operational delivery targets. The process has two main components. The first; review of the existing business structure was completed in 2009. This established a better alignment between people, processes and outcomes. The second; to undertake a significant strategy development project incorporating the three water networks; water supply, wastewater and stormwater. This 3 Waters Strategy project Phases 1 and 2 were completed in 2011, and included the development of hydraulic models examining the entire water cycle within Dunedin's urban catchments, and provided critical information on the performance of the networks. The 3 Waters Strategy are used to inform decisions on future capital expenditure programmes to address the following:

- Current known issues in the networks;
- Urban growth;
- Climate change; and
- Environmental sustainability (particularly in relation to new stormwater consents).

As part of this future strategy the 3 Waters Strategy project has been developed with the aim of providing an integrated decision making process for DCC.

The objectives of the 3 Waters Strategy are:

- Determine required levels of service for each of the three waters networks.
- Determine capital and operational costs associated with improvements to the three waters networks, including priorities and phasing for investment.
- Develop a greater understanding of the operations of the three waters networks through targeted asset and flow data collection.
- Develop decision support tools including network models.
- Develop Integrated Stormwater Catchment Management Plans.
- Provide sufficient data to support the development of council's Annual Plan and Long Term Plan (LTP).

To achieve the objectives of the Strategy the project comprises a three phase process:

Phase 1: Development of capital and operational investment needs at a macro level, determine the needs for more detailed investigations to be carried out in Phase 2, and determine high priority capital and operational works for major infrastructure items to be carried out in Phase 3.

Phase 2: Detailed investigations to determine capital and operational needs at a catchment or zonal level.

Phase 3: Implementation of capital and operational works to realise the required level of service improvements.



## 1.2 Context

The development of the Port Chalmers Integrated Catchment Management Plan 2010-2060 (ICMP) is part of the 3 Waters Strategy being undertaken by DCC, as described above. This ICMP is one of ten long term plans to be developed to fulfil consent requirements relating to the discharge of stormwater to the Otago Harbour, as well as to provide future direction for DCC's stormwater management at a catchment specific scale.

In 2007, short term (five year) stormwater discharge consents were granted by the Otago Regional Council (ORC) permitting stormwater discharges into the Otago Harbour pending the development of stormwater catchment management plans. The emphasis of such plans is on monitoring stormwater quality and mitigating adverse stormwater effects on the harbour's receiving environment. These short term consents will be replaced with long term (35 year) consents following the completion of ICMPs.

Appendix A contains the short term stormwater discharge consents granted for the Port Chalmers catchment (via three individual outfalls). Each consent (Consent Nos. 2002.108, 2002.109, and 2002.222) has a condition which states the following:

*In consultation with the Consent Authority, the consent holder shall prepare and forward to the Consent Authority within four years of the commencement of this consent, a Long Term (35 year) Stormwater Catchment Management Plan for the foreshore catchment that shall contribute to the effective and efficient management of stormwater in that catchment to minimise contamination of stormwater and mitigate any adverse effects caused by contaminant discharge and accumulation in the receiving environment...*

In 2008, a high level Quadruple Bottom Line (QBL) assessment of the ten largest stormwater catchments discharging to the harbour was undertaken, and identified South Dunedin as the highest priority catchment in terms of stormwater issues (refer '*Dunedin 3 Waters Strategy, Stormwater Catchment Prioritisation Framework*'; URS, 2008). Following the development of the ICMP for South Dunedin, the remaining stormwater catchments were re-prioritised, whereby the economic, social, cultural and environmental aspects of the catchments' assets were gauged based on 12 QBL indicators. The four QBL 'wellbeings' (categories) and 12 indicators were each defined and weighted in consultation with DCC Water and Waste Business Unit to ensure that indicators which are considered most important have a greater impact on the final score than indicators which are considered less important at this stage. Each of the remaining nine catchments were then scored against the indicators on a scale of zero to five (zero representing 'no issue' and five, a 'significant issue'), thus producing a final weighted score and ranking of the catchments. The results of this QBL prioritisation assessment are presented in Table 1-1: Phase 2 Catchment Prioritisation

and further details can be found in the report: '*Phase 2 Stormwater Catchment Prioritisation Framework*' (URS, 2009). Port Chalmers was ranked sixth out of the nine catchments compared, with low scores for annual OPEX, reported flooding, and pollution sources.

The scope of works for this ICMP was developed to collect sufficient information about current stormwater management in the catchment, as well as the effects of current practices. Objectives for stormwater management have been set by the 3 Waters Strategic Direction Statement in conjunction with objectives for water supply and wastewater management. Recommendations for future stormwater management are required to meet these objectives, based around avoiding, remedying or mitigating adverse effects of stormwater discharges on both the catchment itself and the receiving environment. Integration of stormwater, wastewater and water supply management is a key



consideration throughout this ICMP, and further opportunities for integrated solutions in this catchment between the water supply, wastewater and stormwater networks, is likely to be in the co-ordination of the DCC capital works programme.



Table 1-1: Phase 2 Catchment Prioritisation

| QBL Category    | Label | Indicator                                           | Main Weighting ( %) | Sub Weighting ( %) | Halsey Street | Orari Street | Mason Street | Kitchener Street | Shore Street | Port Chalmers | Portsmouth Drive | Ravensbourne Road | St Clair |
|-----------------|-------|-----------------------------------------------------|---------------------|--------------------|---------------|--------------|--------------|------------------|--------------|---------------|------------------|-------------------|----------|
| Economic        | 1A    | Annual OPEX                                         | 35                  | 100                | 3             | 2            | 0            | 0                | 0            | 0             | 0                | 0                 | 0        |
| Social          | 2A    | Community Pressures                                 | -                   | -                  | -             | -            | -            | -                | -            | -             | -                | -                 | -        |
| Cultural        | 3A    | Iwi (Kāi Tahu) considerations                       | 20                  | 100                | 4             | 4            | 4            | 4                | 4            | 4             | 4                | 4                 | 3        |
| Environmental   | 4A    | Sensitivity of Receiving Environment                | 45                  | 10                 | 3             | 3            | 3            | 3                | 4            | 3             | 3                | 3                 | 1        |
|                 | 4B    | Asset condition / age / capacity restraints         |                     | 25                 | 3             | 3            | 3            | 3                | 3            | 3             | 1                | 1                 | 3        |
|                 | 4C    | Reported Flooding incidents                         |                     | 10                 | 4             | 2            | 3            | 1                | 2            | 1             | 1                | 3                 | 2        |
|                 | 4D    | Reported Water Quality incidents                    |                     | 10                 | 4             | 2            | 4            | 3                | 1            | 3             | 1                | 0                 | 2        |
|                 | 4E    | Presence of point source pollution sources          |                     | 20                 | 3             | 2            | 3            | 3                | 1            | 2             | 4                | 4                 | 1        |
|                 | 4F    | Presence of diffuse pollution sources               |                     | 10                 | 3             | 2            | 3            | 3                | 2            | 0             | 5                | 3                 | 1        |
|                 | 4G    | Development proposed within catchment               |                     | -                  | -             | -            | -            | -                | -            | -             | -                | -                 | -        |
|                 | 4H    | Sediment generating / erosion areas                 |                     | 10                 | 3             | 2            | 2            | 1                | 2            | 1             | 0                | 0                 | 2        |
|                 | 4I    | Potential for waste / stormwater system interaction |                     | 5                  | 4             | 3            | 4            | 2                | 2            | 4             | 1                | 1                 | 2        |
| Weighted Score: |       |                                                     |                     |                    | 3.31          | 2.58         | 2.17         | 1.95             | 1.77         | 1.77          | 1.75             | 1.7               | 1.43     |
| Rank:           |       |                                                     |                     |                    | 1             | 2            | 3            | 4                | 5            | 6             | 7                | 8                 | 9        |



### 1.3 Overview

This ICMP comprises six parts:

**Part 1 – Introduction.** This section provides the background to the study, and outlines the planning and statutory requirements of DCC with respect to stormwater discharge management.

**Part 2 – Baseline.** This part of the report describes the stormwater catchment as it is now – topography, land use, receiving environments, stormwater discharge quantity and quality. The stormwater network is also described and current operational and capacity issues discussed.

**Part 3 – Analysis.** Stormwater management problems and issues are identified in this section, by analysing the results of contaminant and network modelling, flood hazard mapping and other information collated in previous sections.

**Part 4 – Targets.** Catchment stormwater management approaches and SMART targets are outlined in this section, as determined by the priority of each issue, and DCC's stormwater management objectives.

**Part 5 – Solutions.** This section describes a number of potential solutions to the issues identified (stormwater quantity and quality).

**Part 6 – Way Forward.** A prioritised programme of works is outlined, based on the Optimised Decision Making Framework developed for the DCC 3 Waters Strategy.

Figure 1-1 presents the scope of work for the stormwater component of the 3 Waters Strategy, including prioritisation of the catchments.

Figure 1-2 provides a process diagram of the ICMP process used for this project. The figure also indicates the position and influence of stakeholder consultation within this process. Ongoing consultation ensures that the project advances in a way that meets the needs and expectations of all parties involved. It can also significantly benefit the project by providing invaluable local knowledge and assist in identifying significant issues. Furthermore, successful consultation during development stages can often assist implementation of the ICMP.

An ICMP document is designed to accommodate a number of changes during its useful life, via monitoring and review processes (refer Section 17). Changes within the catchment, results of monitoring, or improved system knowledge are a number of things that may prompt a change in the ICMP.

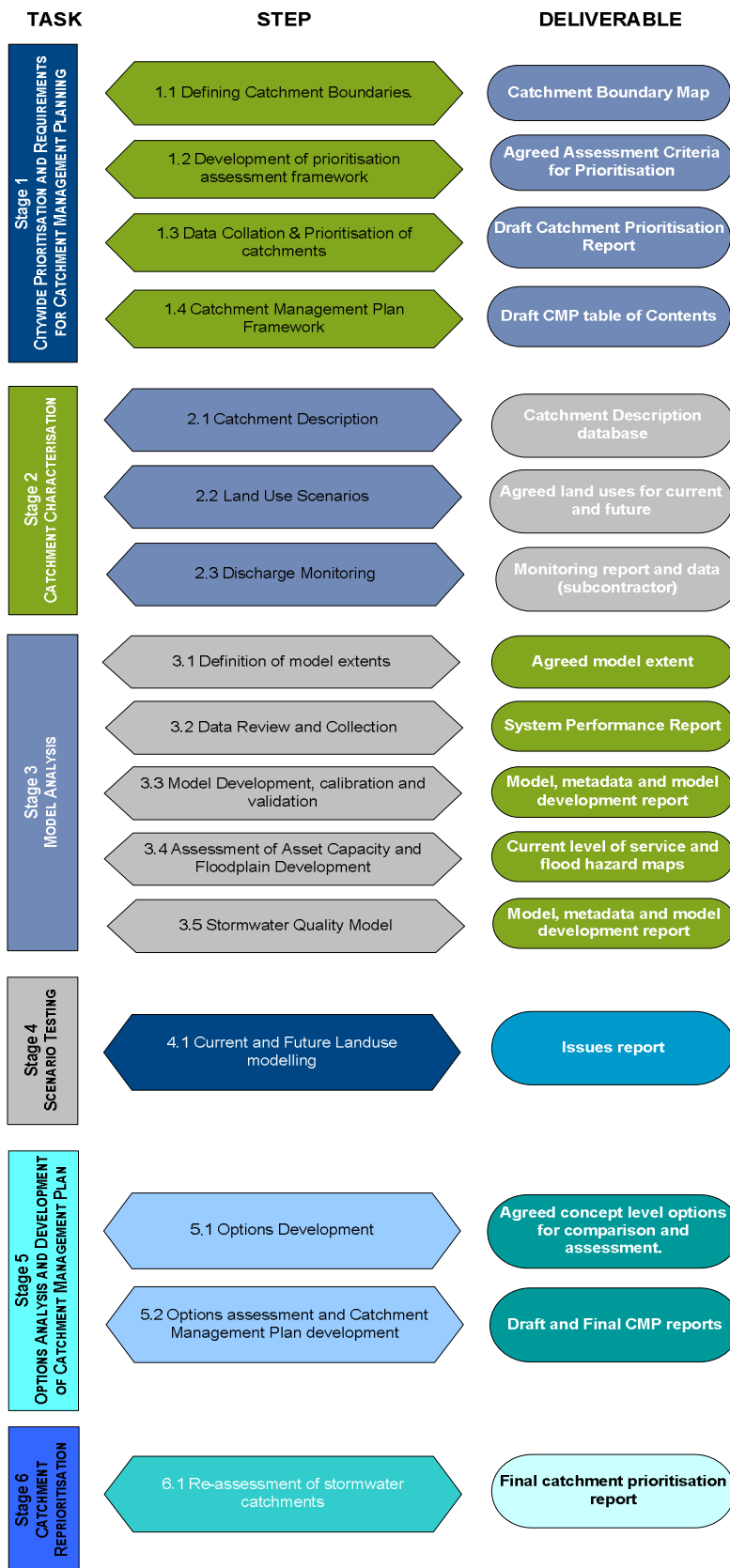


Figure 1-1: Scope of Work

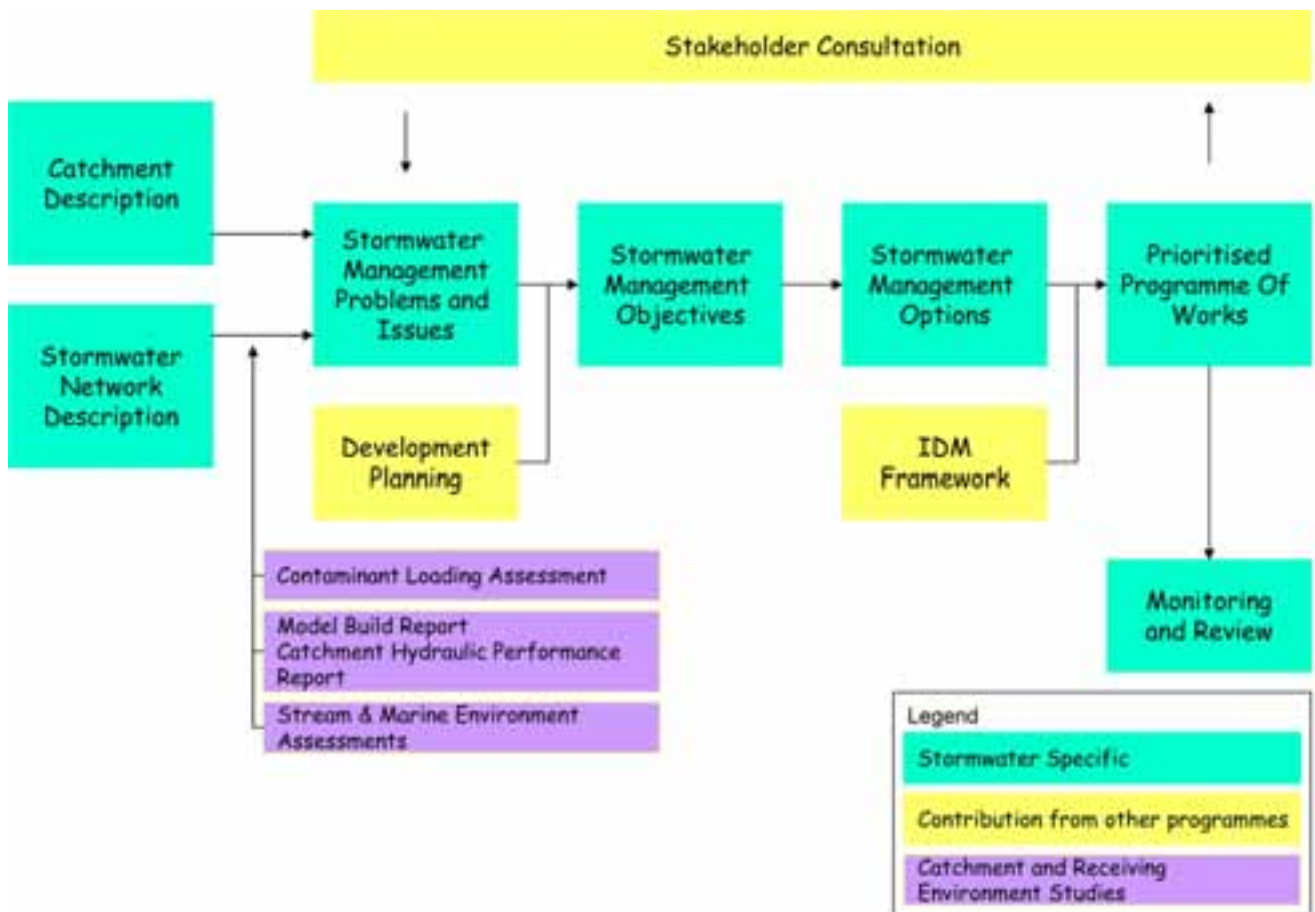


Figure 1-2: ICMP Development Process



## 2 Planning and Statutory Background

### 2.1 Planning Framework

An ICMP and any stormwater development undertaken where the ICMP is applied should be consistent with the objectives of central, regional and district planning documents and key non-statutory strategic documents. Figure 2-1 provides the hierarchies of legislative and planning documents, both statutory and non-statutory which interact with the ICMP. As shown by the double ended arrows, there is often a two way interaction between the ICMP and these documents.

The influence of each of the key current statutory and non-statutory documents relating to stormwater management and the development of an ICMP are discussed in Sections 2.2 to 2.7. It is important to note that these documents are subject to review and change. Therefore, the ICMP needs to be sufficiently flexible to endure variations to these documents while remaining relevant. In some cases the ICMP may provide direction to these variations.

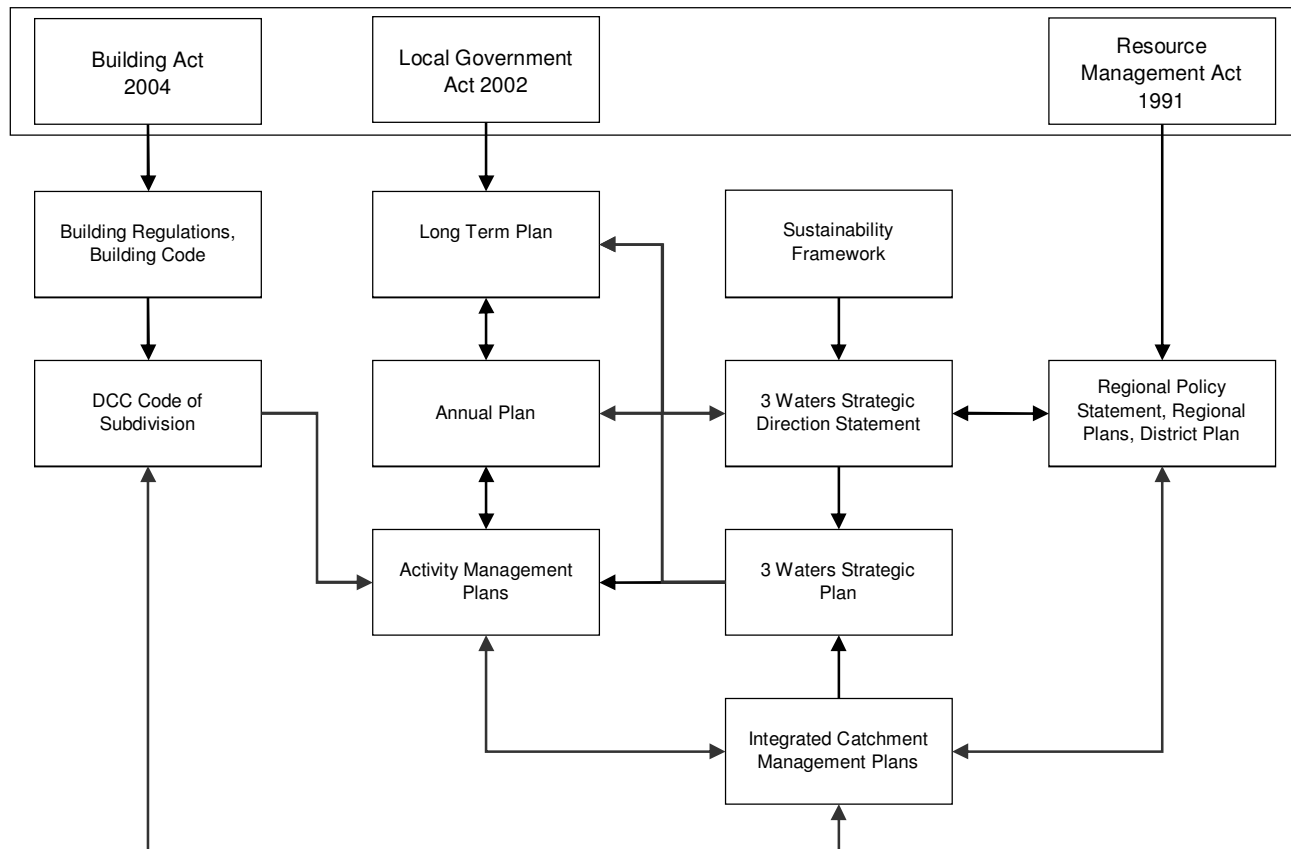


Figure 2-1: Legislative and Planning Document Hierarchies



## 2.2 The Local Government Act (2002)

The purpose of the Local Government Act 2002 (LGA) is to provide for democratic and effective local government that recognises the diversity of New Zealand communities and, to that end, this Act—

- (a) *States the purpose of local government; and*
- (b) *Provides a framework and powers for local authorities to decide which activities they undertake and the manner in which they will undertake them; and*
- (c) *Promotes the accountability of local authorities to their communities; and*
- (d) *Provides for local authorities to play a broad role in promoting the social, economic, environmental, and cultural wellbeing of their communities, taking a sustainable development approach.*

There are a number of responsibilities outlined within the LGA which are relevant to the ICMP. These include:

- Section 93, LTP;
- Section 95 Annual Plan; and
- Compliance with performance measures set by the Secretary of Local Government.

These are discussed in further detail below.

An ICMP needs to be consistent with the LGA. This can be achieved by promoting consultation with all parties affected by stormwater management decisions and accounting for and managing the stormwater infrastructure for Dunedin City in a manner that provides for the present and future needs of the public and the environment.

### 2.2.1 Long Term Plan (LTP)

Section 93 of the LGA requires a local authority to produce a LTP for the following purposes:

*“to describe the activities of the local authority; to describe community outcomes; to provide integrated decision making and co-ordination of resources; to provide a long term focus for decisions and activities; and provide a basis for the accountability of the local authority to the community.”; and to provide an opportunity for participation by the public in decision making processes.”*

### 2.2.2 Annual Plan

The Annual Plan required under Section 95 of the LGA supports the LTP by providing for the co-ordination of local authority resources, contributing to the accountability of the local authority to the community, and extending the opportunities for participation by the public in decision making relating to costs and the funding of local authority activities.



### 2.2.3 Performance Measures

The Secretary of Local Government is required to provide regulations that establish rules specifying performance measures for water supply; sewerage treatment / disposal; stormwater; flood protection and the provision of roads and footpaths. The performance measures relating to stormwater, wastewater and flood protection will need to be taken into account when developing solutions under the ICMP.

### 2.2.4 Trade Waste Bylaw

The DCC Trade Waste Bylaw 2008 regulates the discharge of Trade Waste to a Sewerage System operated by DCC. The purpose of the Bylaw is:

*“to control and monitor trade waste discharges into public sewers in order to ... (v) protect the stormwater system.”*

Section 4A of the Bylaw states that it is an offence to discharge stormwater into the stormwater system that does not satisfy the discharge acceptance standards outlined in Schedule 1E of the Bylaw. Schedule 1E contains a number of acceptance standards, including limitations on the quality of the stormwater.

## 2.3 Resource Management Act (1991)

The purpose of the Resource Management Act (RMA) as defined in Section 5 of the Act, is to promote the sustainable management of New Zealand's natural and physical resources. This is to be achieved by managing the use of resources, in a manner that allows for people and communities to provide for their social, economic and cultural wellbeing, while sustaining the potential of natural and physical resource to meet the needs of future generations; safeguarding the life supporting capacity of air, water, soil and ecosystems; and avoiding, remedying or mitigating adverse effects of activities on the environment.

Section 6; Matters of National Importance, Section 7; Other Matters and Section 8; Treaty of Waitangi outline values which all persons exercising functions and powers under the RMA shall recognise and provide for, have particular regard to and take into account when achieving the purpose of the RMA.

Sections 14 and 15 of the RMA place restrictions on taking and using water, and on the discharge of contaminants into the environment.

In relation to stormwater management, the RMA therefore addresses the following:

- The need to sustainably manage our water resources to meet the needs of future generations;
- The need to preserve the natural character of our coastal environment, wetlands, lakes, rivers and their margins;
- Recognising and providing for the relationship of Māori with their ancestral lands and water;
- The control of the use of land for the purpose of the maintenance and enhancement of the quality of water in water bodies and coastal water;
- The control of discharges of contaminants and water into water;
- The control of the taking, use, damming and diversion of water, and the control of the quantity, level and flow of water in any water body, including:



- i) The setting of any maximum or minimum levels or flows of water; and
- ii) The control of the range, or rate of change, of levels or flows of water.

It is considered that the development and implementation of an ICMP which is consistent with the purpose and principles of the RMA, will allow for the identification of in-catchment values, such as drainage patterns and sensitive receiving environments. Management recommendations are then made based on the best practicable option, to ensure that the natural and physical environment within a stormwater catchment and its receiving environment are managed sustainably. This approach helps to ensure that the natural and physical resources within Dunedin's stormwater catchments are used in a way that provides for the community's social, economic and cultural wellbeing.

### 2.3.1 The New Zealand Coastal Policy Statement (2010)

The purpose of the New Zealand Coastal Policy Statement 2010 (NZCPS) is to outline policies relevant to the coastal environment to achieve the purpose of the RMA. The term 'coastal environment' is broad, and although undefined in the RMA, it is generally considered an environment in which the coast is a significant element or part.

The NZCPS requires persons exercising functions and powers under the RMA to:

- Safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems, including marine and intertidal areas, estuaries, dunes and land;
- Preserve the natural character of the coastal environment and protect natural features and landscape values;
- Take account of the principles of the Treaty of Waitangi, recognise the role of tangata whenua as kaitiaki and provide for tangata whenua involvement in management of the coastal environment;
- Maintain and enhance the public open space qualities and recreation opportunities of the coastal environment, enable people and communities to provide for their social, economic, and cultural wellbeing and their health and safety, through subdivision, use, and development; and
- Ensure that management of the coastal environment recognises and provides for New Zealand's international obligations regarding the coastal environment, including the coastal marine area (CMA).

Policies within the NZCPS contain potential restrictions on the activities likely to be undertaken in relation to stormwater management and have been considered when making recommendations within this ICMP. Policy 23 (2) and (4), addressing the discharge of contaminants has particular relevance for Dunedin City.

Policy 23(2)(a) does not allow discharges of human sewage directly to water in the coastal environment without treatment unless there has been adequate consideration of alternative methods, sites and routes for undertaking the discharge that have been informed by an understanding of tangata whenua values and the effects on them. DCC does not currently have any planned direct sewage discharges. However the wastewater infrastructure network does have emergency overflow facilities to the coastal environment. These facilities are to accommodate emergency overflow discharges only. All discharges during non emergency events are provided for through the existing



wastewater network. Adequate consideration has been given to alternatives to a coastal discharge by providing an alternative for any non emergency events therefore the current discharge scenario is consistent with this policy.

Policy 23(4) outlines steps to be taken to avoid the effects of a stormwater discharge on water in the coastal environment. These steps include:

- Avoiding where practicable and otherwise remedying cross contamination of sewage and stormwater systems;
- Reducing contaminant and sediment loadings in stormwater at source, through contaminant treatment and by controls on land use activities;
- Promoting integrated management of catchments and stormwater networks; and
- Promoting design options that reduce flows to stormwater reticulation systems at source.

The ICMP process by definition promotes the integrated management of catchments. Recommendations made within the ICMP will incorporate the other steps outlined where appropriate or required as determined by the results of stormwater quality and quantity monitoring.

The Port Chalmers catchment discharges into the Otago Harbour, which links with the Pacific Ocean, therefore the NZCPS must be considered when developing and implementing the ICMP. The ICMP provides a detailed assessment of the effects of current land use and development within the Port Chalmers catchment on the Otago Harbour. It is considered that the ICMP approach is consistent with the holistic nature of the NZCPS in particular Policy 23(4)(c), and that the stormwater management options considered by the ICMP regarding stormwater management options such as source control, treatment devices, low impact design, and community education will ensure that the adverse effects of stormwater runoff on the coastal environment will be avoided, remedied or mitigated.

### 2.3.2 Marine and Coastal Area Act (2011)

The Marine and Coastal Area Act repeals the Foreshore and Seabed Act 2004, and removes Crown ownership of the public foreshore and seabed.

The Act provides that any part of the common marine and coastal area owned by a local authority will form part of the common marine and coastal area, divesting local authorities of those areas. Current freehold title in existing reclamations would remain.

The Act states that resource consents in the common marine and coastal area that were in existence immediately before the commencement of the Act are not limited or affected by the Act. Existing leases, licences, and permits will run their course until expiry. Coastal permits will be available for the recognition of these interests after expiry.

The Act provides that, while there is no owner of the common marine and coastal area, existing ownership of structures and roads in the area will continue. New structures can be privately owned. Structures that have been abandoned will vest in the Crown so that it can ensure that health and safety laws are complied with.

The Marine and Coastal Area Bill was enacted on 24 March 2011. Stakeholder consultation will incorporate discussion on the Marine and Coastal Area Act.



### 2.3.3 National Environmental Standards

While there are currently no National Environmental Standards (NES) relevant to this ICMP, it is assumed that NES will be developed in time for the type of activities covered under this ICMP. As local or regional councils must enforce standards imposed by a NES, the ICMP must be flexible enough to incorporate these standards.

### 2.3.4 The Otago Regional Policy Statement (1998)

The Otago Regional Policy Statement (ORPS) is an operative document giving effect to the RMA. The ORPS discusses issues, objectives and policies relating to managing the use, development and protection of the natural and physical resources of the region. The ORPS identifies regional issues and provides a policy framework for managing environmental effects associated with urban and rural development.

The ICMP is influenced by the ORPS and the planning documents which sit below it (i.e. the Regional Plans). There are a number of policies contained within the ORPS which are relevant to the ICMP. Of particular relevance are Policies 6.5.5, 7.5.3, 8.5.6, 9.5.4 which seek to reduce the adverse effects on the environment of contaminant discharges through the management of land use, air discharges, coastal discharges and the built environment. The management options discussed include adopting baseline water quality standards and where possible improving the quality of water to a level above these baselines. The policies mentioned give general guidance to any stormwater management initiatives within the Region by identifying anticipated environmental outcomes. This general guidance is the main starting point for determining the direction of the ICMP.

The ORPS also addresses natural hazards in Policies 11.5.2, 11.5.3 and 11.5.4. These policies give direction to hazard management through outlining steps that should be taken to avoid or mitigate the effects of natural hazards. With flooding being an issue within the Port Chalmers catchment, these overarching policies may play a significant role in providing direction for the ICMP if natural hazards are determined to be a priority.

The ORPS was due for full review in October 2008 however at the time this report was written the review process had not been initiated.

### 2.3.5 The Regional Plan: Coast for Otago

The purpose of the operative Regional Plan: Coast for Otago (Coastal Plan) is to provide a framework to promote the integrated and sustainable management of Otago's coastal environment. The Coastal Plan recognises that the coastal environment is one of the integral features of the Otago Region, and that it is dynamic, diverse and maintained by a complex web of physical and ecological processes. One of the principle considerations for this ICMP is the discharge of contaminants into the CMA.

Chapter 10 of the Coastal Plan addresses the discharge of contaminants to the CMA. This chapter contains a number of policies addressing issues such as: the effects of any discharge on Kāi Tahu values; avoiding effects on coastal recreation areas; areas of significant landscape or wildlife habitat value; water quality; mixing zones; and discharge alternatives.

Policy 10.4.1 states that for any discharges to the CMA that are likely to have an adverse effect on cultural values Kāi Tahu will be treated as an affected party. Details relating to issues of particular significance are contained within the Kāi Tahu ki Otago Natural Resource Management Plan which is addressed below.



Objective 10.3.1 seeks “to maintain existing water quality within Otago’s coastal marine area and to seek to achieve water quality within the coastal marine area that is, at a minimum, suitable for contact recreation and the eating of shellfish within 10 years of the date of approval of this plan”. Further, Policy 10.4.3 states that where water quality already exceeds these standards, water quality should not be degraded beyond the limits of a mixing zone associated with each discharge.

### 2.3.6 The Regional Plan: Water for Otago

The operative Regional Plan: Water for Otago (Water Plan) considers the use, development and protection of the fresh water resources of the Otago region, including the beds and margins of water bodies. Chapter 7 of the Water Plan outlines objectives and policies to address those issues relating to water quality and discharges.

Policies 7.7.3, 7.7.4, 7.7.5 and 7.7.7 outline matters which need to be considered when assessing resource consents for discharges including cumulative effects, the sensitivity of the receiving environment and any relevant standards. Policies 7.7.10 and 7.7.11 address stormwater systems directly, identifying required outcomes for new systems and requiring the progressive upgrade of older systems. These policies provide both general and specific guidance for any stormwater system or associated discharge within the Port Chalmers catchment and play a strong role in determining the suitability, consentability and priority of any management option chosen under the ICMP.

### 2.3.7 The Dunedin City District Plan

The operative Dunedin City District Plan identifies issues and states objectives, policies and methods to manage the effects of land use activities on the environment.

The Dunedin City District Plan applies to all users of land and the surface of water bodies within the city; it is concerned with all areas above the line of mean high water springs (MHWS). Issues pertaining to those areas below the line of MHWS, including coastal waters, are addressed in the Otago Regional Plan: Coast for Otago and the NZCPS.

Policy 21.3.1 seeks to protect the harvest potential and quality of water within catchments. Policy 21.3.8 seeks to avoid or otherwise remedy or mitigate the adverse effect of activities which discharge to water, land or air. While standards relating to water quality are the jurisdiction of ORC, the policies contained within the Dunedin City District Plan address the effects of land use on water quality for example through the consideration of matters such as stormwater runoff from subdivisions.

The Dunedin City District Plan also uses land use zoning as a method of regulating activities under DCC jurisdiction. These land uses will play an integral part in determining the quantity and quality of any stormwater runoff. The Port Chalmers catchment consists of Residential 1, Rural, Local Activity Zone 1, and small areas of Industrial 1 and Port 1 land uses. Activities which are permitted to occur within these zones include: primary activities based on livestock, horticulture and forestry, port activities, residential housing, industrial activity, service activity, retail activity specific to and complimentary to industrial or service activity, recreational activity, service stations, vehicle and boat yards and garden centres.



## 2.4 Building Act (2004)

The Building Act 2004 includes Sections 71 to 74 which relate to limitations and restrictions on building consents and the construction of buildings on land subject to natural hazards. Flooding is the primary natural hazard of concern within the Port Chalmers catchment therefore the ICMP needs to ensure that any development within the catchment will not exacerbate the risk of flooding.

The Building Regulations 1992 include the Building Code, which provides guidance as to the implementation of the Building Act. Section E of the Building Code includes various performance criteria relating to stormwater systems which are relevant to the ICMP. These criteria are specific to managing natural hazards and include drainage system design and inundation probability criteria. The ICMP will need to reference the performance criteria outlined within the code when identifying management options.

## 2.5 Civil Defence Emergency Management Act (2002)

The Civil Defence Emergency Management Act 2002 (CDEMA) addresses the management of emergencies including flooding. Section 64(1) of the CDEMA outlines the duties of local authorities and states:

*“A local authority must plan and provide for civil defence emergency management within its district.”*

Producing flood maps as part of the ICMP process may be one method of providing for civil defence emergency management however this method is not specifically prescribed by the CDEMA and therefore is at the discretion of the local authority concerned.

## 2.6 Non Statutory Documents

### 2.6.1 Kāi Tahu ki Otago Natural Resource Management Plan

Kāi Tahu ki Otago Natural Resource Management Plan (Kāi Tahu Plan) provides a background to Kāi Tahu's resource management issues in the Otago Region. The Kāi Tahu Plan contains management guidelines and objectives relating to freshwater fisheries and coastal resources. Kāi Tahu are particularly concerned with the destruction of the freshwater resource as a result of piping and channelisation, the mauri and life supporting capacity of water being compromised by structures and point source discharges, and the depletion of coastal fisheries due to discharges to the CMA.

The ICMP should consider the specific concerns of Kāi Tahu where they are not addressed by the regional or district statutory planning documents, and should ensure that Kāi Tahu are considered as a potentially affected party where appropriate.

### 2.6.2 Code of Subdivision and Development

Chapter 18, Subdivision of the Dunedin City District Plan, contains Method 18.4.1 which makes reference to the Dunedin Code of Subdivision and Development. This code is not part of the Dunedin City District Plan but does contain guidelines, including levels of service, for any physical works (such as kerb and channel design) associated with subdivision activity, which are considered when assessing consent applications. Stormwater targets and management approaches proposed by the ICMP should ensure this code is complied with. It is also likely that the content of the ICMP may also help shape the future direction of the Code.



### 2.6.3 The Dunedin City Council Sustainability Framework

The DCC Sustainability Framework is a relatively new non-statutory document which has an overarching influence on all aspects of DCC's operations and decision making through the following sustainability principles:

- Affordable: reasonable cost, value for money, today / future costs.
- Environmental Care: clean energy, bio-diversity, safe.
- Enduring: forward looking, whole of life, long term, future generations.
- Supporting People: social connectivity, social equity, quality of life, safe.
- Efficient: using less, creating less waste, smarter use.

These sustainability principles will influence the content of this ICMP and any recommendations with regard to future capital works.

### 2.6.4 3 Waters Strategic Direction Statement and 3 Waters Strategic Plan

The purpose of the 3 Waters Strategic Direction Statement is to align the management of Dunedin's three waters activities with the city's sustainability principles. This document provides direction for the detailed 3 Waters Strategic Plan which will be largely influenced by the content of all of the ICMPs. It is through the 3 Waters Strategic Plan that the ICMPs will provide input to long term community planning objectives and ultimately, Activity Management Plans (AMPs) and capital works programmes for stormwater.

### 2.6.5 Activity Management Plans

The DCC stormwater, wastewater and water supply AMPs contain objectives, levels of service, methods for delivering this service, asset management and levels of funding in relation to each activity. These plans are developed through the long term community planning process. The ICMP provides input to the content of the AMPs through its contribution to the 3 Waters Strategic Plan.

## 2.7 Resource Consents

This section outlines the classifying rules in the Dunedin City District Plan and the Regional Water and Coastal Plans which are relevant to the activities likely to occur under the ICMP.

While there are no rules within the Dunedin City District Plan classifying the discharge of stormwater, the ICMP needs to be consistent with the policies and objectives of the Dunedin City District Plan as described in Section 2.3.7, by incorporating further investigations of the system and environment and monitoring any discharges that are occurring.

Most consent requirements will be addressed by The Regional Plan: Water for Otago and The Regional Plan: Coast for Otago. The Dunedin City District Plan however, contains methods for addressing water quality issues through investigations, monitoring, education, consultation and the creation of management plans such as this ICMP.

Rule 10.5.3 of the Regional Plan: Coast for Otago classifies the discharge of stormwater into the CMA as a permitted activity provided certain conditions are met. These conditions include restrictions on the type of discharge, the receiving environment and any effects of the discharge.



Stormwater discharge from the Port Chalmers catchment is unlikely to comply with the conditions of Rule 10.5.3 due to the catchment containing industrial or trade land uses. Any stormwater discharge would therefore be classified as controlled under Rule 10.5.3.2 and would require a resource consent with ORC exercising its control over matters such as; the location, volume, rate and nature of the discharge.

It is recommended that the objectives of the ICMP align as closely as possible with the permitted activity rules to enable the objectives of the Coastal Plan to be met, where possible.

Rules 12.4 and 12.5 of the Regional Plan: Water for Otago classify the discharge of stormwater and the discharge of drainage water to water.

Rule 12.4.1 classifies the discharge of stormwater to water as a permitted activity provided that certain conditions are met. These conditions, among others include that; the discharge does not contain any human sewage, the discharge does not cause flooding of any other person's property, erosion, land instability, sedimentation or property damage and does not produce any conspicuous oil or grease films, scums or foams, or floatable or suspended materials or objectionable odours.

Should the conditions outlined in this rule not be met then the discharge of stormwater to water will be classified as a restricted discretionary activity requiring resource consent.

Rule 12.5.1 classifies the discharge of drainage water to water as a permitted activity provided the discharge does not cause flooding of any other person's property, erosion, land instability, sedimentation or property damage and does not produce any conspicuous oil or grease films, scums or foams, floatable or suspended materials or objectionable odours.

If the conditions outlined in Rule 12.5.1 cannot be satisfied, then the discharge of stormwater to water will be classified as a restricted discretionary activity requiring resource consent.

The objectives of the ICMP should be aligned as closely as possible to the permitted activity rules to enable the objectives of the Water Plan to be met where possible.

## 2.8 Objectives of Stormwater Management

### 2.8.1 Strategic Objectives

The strategic objectives of stormwater management are outlined in Table 2-1 and provide the overarching objectives that guide the development of this ICMP. These objectives are at the core of the relevant statutory and non-statutory documents addressing stormwater management, including the 3 Waters Strategic Direction Statement. These objectives have been developed with the aim of achieving benefits across the four wellbeings (environmental, social, economic and cultural), and have been set within the context of a 50 year timeframe.



Table 2-1: Strategic Stormwater Management Objectives

| Strategic Objectives                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Development:</b> Adapt to fluctuations in population while achieving key levels of service and improving the quality of stormwater discharges. Ensure new development provides a 1 in 10 year level of service, and avoids habitable floor flooding during a 1 in 50 year event. |
| <b>Levels of service:</b> Maintaining key levels of service of the stormwater network into the future by adapting to climate change and fluctuations in population, while meeting all other objectives.                                                                             |
| <b>Environmental outcomes:</b> Improve the quality of stormwater discharges to minimise the impact on the environment and reduce reliance on non-renewable energy sources and oil based products.                                                                                   |
| <b>Tangata whenua values:</b> Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges.                                                                                                        |
| <b>Natural hazards:</b> Ensure there will be no increase in the numbers of properties at risk of flooding from the stormwater network.                                                                                                                                              |
| <b>Affordability:</b> To meet strategic objectives while limiting cost increases to current affordability levels where practical.                                                                                                                                                   |

### 2.8.2 Activity Management Plan / LTP Objectives and Targets

Table 2-2 outlines shorter term objectives, performance measures and targets derived from DCC's stormwater AMP and LTP. These objectives are to be reviewed annually but are set within the context of a 10 year timeframe. Therefore the measures and targets may be subject to development or change based on findings from the ICMP development process. Influencing factors may include stormwater modelling results, or further research into costs surrounding changes to levels of service.

DCC also intend to begin reporting on a number of additional measures and targets relating to service provision. The ICMP development should inform this process, and help to identify the most appropriate measures and provide baseline information. It is intended that the following areas will be able to be reported on following the ICMP completion if appropriate and necessary:

- Number of written complaints;
- Number of properties with habitable floor stormwater flooding;
- Percentage of customers with stormwater provision that meets current design standards;
- Percentage of modelled network able to meet a 1 in 10 yr ARI rainfall event; and
- Number of properties at risk of stormwater flooding in a 1 in 10 year event.



**Table 2-2: Activity Management Plan Measures and Targets**

| Objective                        | Performance Measure                                                                      | 2010 / 2011 Target          | 2021 Target                     |
|----------------------------------|------------------------------------------------------------------------------------------|-----------------------------|---------------------------------|
| Stormwater Quality               | Residents' satisfaction with the stormwater collection service                           | ≥ 60 %                      | ≥ 70 %                          |
|                                  | Number of blockages in the stormwater network per 100 km of mains per annum              | < 15                        | < 10                            |
|                                  | Number of beach closures                                                                 | 0                           | 0                               |
| Service Availability             | Percentage of customer emergency response times met (Stormwater)                         | ≥ 95 %                      | ≥ 95 %                          |
| Demand Management                | Completion of stormwater catchment management plans                                      | as plan                     | X (should be completed by 2013) |
| Environmental Consent Compliance | Percentage compliance with stormwater discharge consents                                 | ≥ 75 %                      | tbc                             |
|                                  | Number of prosecutions or infringement notices for non-compliance with resource consents | 0                           | 0                               |
|                                  | Number of recorded breaches of RMA conditions                                            | 0                           | 0                               |
| Asset Serviceability             | Number of breaks per 100 km of stormwater sewer per annum                                | < 1                         | < 1                             |
|                                  | < x % of critical network assets in condition grade 4 or 5                               | To increase % of known data | tbc                             |
| Supply Cost per m <sup>3</sup>   | Drainage uniform annual charge as a percentage of median income                          | ≤ 1 %                       | ≤ 1 %                           |
|                                  | Total operational cost of stormwater service per rated household                         | \$ 76.70                    | tbc                             |

tbc: To be confirmed



### 3 Consultation

During the application for coastal discharge consents in 2005, through Annual Plan consultation and through specific consultation in relation to the 3 Waters Strategy, a number of stakeholders have been identified as affected by, or interested in stormwater management in Dunedin. The following provides a summary of values identified through the consultative processes mentioned. These values have been considered when developing objectives and options for stormwater management of identified issues.

#### 3.1 3 Waters Strategy Consultation- Stakeholder Workshops and Community Survey

For specific consultation relating to the 3 Waters Strategy, stakeholders were divided into three groups; environmental, economic / business and social / cultural. The outcomes of the specific consultation workshops were used to inform a community telephone survey to gauge the views of the wider community including catchment residents. Specific groups were also consulted directly, including: Kāi Tahu ki Otago, ORC and East Otago Taiapure Management Committee. From all consultation relating to the 3 Waters Strategy there was a general recognition that stormwater requirements and standards will need to increase, in terms of both quality and volume management.

A coordinated approach to stormwater management between ORC and DCC is desired; with the responsibilities for each organisation being clarified.

Overall, increasing the sustainability and efficiency of the network is also desired.

#### Views Relating to Quality

- A high awareness that stormwater contains many contaminants, and thus its management is not just a matter of transportation to the coast.
- That quality involves household drains and farm runoff as well as road runoff and sewage contamination.
- Recognise that the stormwater system does include recreational places, which underlines the need for better quality stormwater.
- Improving quality of disposed stormwater is a key issue – the higher the quality, the better.

#### Views Relating to Volume

- Recognition that climate change may result in more frequent storm events, thus putting a greater episodic demand on the system; and thus likely to require increased capacity. This may be compounded by decreases in permeable land resulting from increased property development in certain areas.
- That managing volumes (which is partially related to quality) requires a more encompassing view of the system and its management.

In summary, the consultation identified that the key points in relation to stormwater management were:

- Legislative changes, e.g. changing planning or building consents standards to further reduce the impact of new developments on stormwater;



- Passive changes, e.g. increasing the use of swales and soakholes to better manage storm events, using landscaping to reduce the visual pollution of outfalls;
- Active changes, e.g. increasing outfall pipe numbers to reduce the impact in any given area; increasing treatment standards; installing low-flow regulators;
- Doing more than simply increasing pipe capacity – i.e. review requirements for new property developments, in order to reduce runoff volumes and minimise the loss of permeable land; and
- Consideration of sustainable options e.g. stormwater captured and used by households; implementing alternative energy sources for pump stations (such as wind turbines or micro hydro-electricity generators). In rural areas, also capture stormwater in detention ponds, both to slow flows and prevent flooding but also to balance with demand for other water-use activities e.g. irrigation.

During the development of the 3 Waters Strategic Direction Statement, objective setting took the results of the community consultation into account, for example by incorporating statements relating to the use of source control for stormwater management. The ICMP approach to stormwater management also considers a range of management options for stormwater, described as 'legislative, passive and active' changes above.

### 3.2 Resource Consent Submissions

The resource consent process for the coastal discharge permits identified the residents within the affected catchments as interested parties. Matters raised by submitters in relation to coastal stormwater discharge permit applications are also a valuable source of stakeholder opinion. A majority of the submissions echo the views outlined above however the Kāi Tahu cultural impact assessment (CIA) outlined below goes into more detail. As part of the consent conditions for stormwater discharges, annual meetings are held with Save The Otago Peninsula Society Incorporated, and the Department of Conservation (DOC) Otago Conservancy.

#### 3.2.1 Kāi Tahu Cultural Impact Assessment

In October 2005, DCC commissioned Kāi Tahu ki Otago Limited (KTKO Ltd.) to undertake a CIA (KTKO Ltd., 2005) on the discharge of stormwater into Otago Harbour and at Second Beach. This report was commissioned as part of the consent application process for the current discharge consent held for this catchment.

The report details historical use of the Otago Harbour by Kāi Tahu and their descendents, particularly for transport and as a food resource (mahika kai).

The report studies the reported levels of contaminants in the stormwater discharged to the harbour, and also in sediments within the harbour, and states that runanga are concerned about the lack of information on biological impacts, on effects further afield than the immediate area of discharge, and that they are also concerned about the possibility of wastewater discharge into the harbour. Resource consent conditions for the current stormwater discharges include sampling and monitoring of sediments within the wider harbour, and biological monitoring. At present, given the size of the receiving environment, sampling and monitoring as part of the resource consent conditions is limited, and restricted to once per year and in a small number of locations. As sampling continues, understanding of the biological impacts of the stormwater discharges should increase.



Discharge of stormwater and associated contaminants has the potential to significantly impact Kāi Tahu values and beliefs. These adverse impacts are associated with effects on the spiritual value of water, mahika kai, aquatic biota and water quality.

The traditional resource management methods of Kāi Tahu require coordinated and holistic management of the interrelated elements of a catchment, from the air to the water, the land and the coast. The CIA notes that it is accepted by Kāi Tahu that removal of all contaminants from stormwater is not possible. However, it is also considered that more could be done to reduce the level of contaminants discharged. Recommended management measures for consideration are as follows:

- Reducing the area of impervious land;
- Use of grass swales to filter stormwater;
- Covering car-parking areas and other areas where increased contaminants may be found;
- Sediment / grease traps to be installed at all industrial premises, petrol stations and car parks;
- Management plans for industrial and commercial facilities to minimise the contaminant loading into stormwater, including the management of spills;
- Ensuring industrial waste is not discharged to the stormwater system;
- Ensuring there is no discharge of human sewage to the stormwater system; and
- Ongoing awareness of best management practices and technological improvements that will reduce contaminant levels and a willingness to implement these as appropriate.

As with the wider community consultation results, it is considered that the ICMP approach to stormwater management encompasses much of what is desired by Kāi Tahu, as described above. The 3 Waters Strategic Direction Statement objectives used by this ICMP support the use of source control and low impact design options for stormwater management, as suggested above by Kāi Tahu, as well as looking to reduce the incidence of wastewater discharge into the receiving environment.

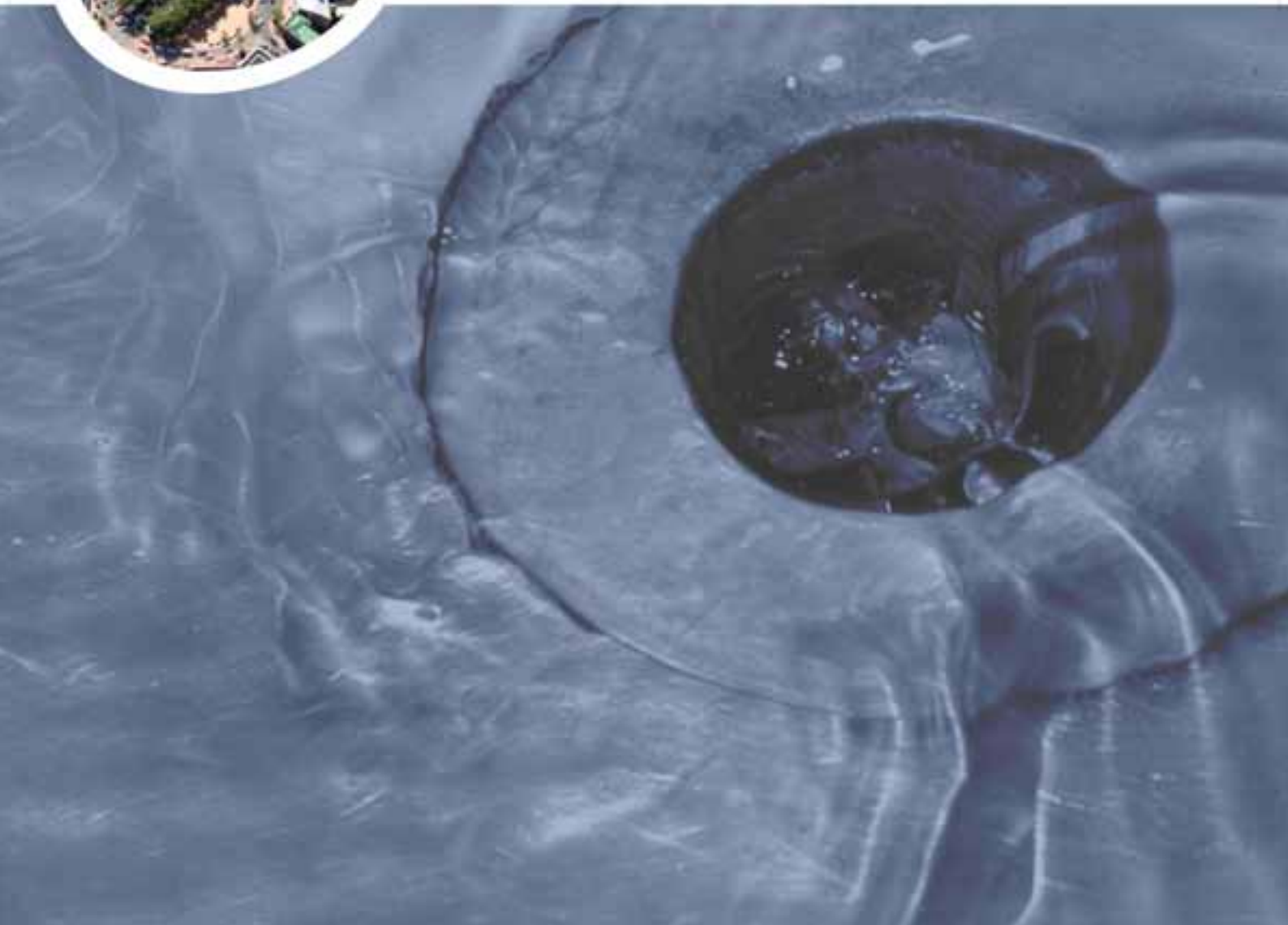
### 3.3 Annual Plan Submissions

A number of submissions were made with respect to stormwater issues through the 2009 Annual Plan consultation process. These submissions mainly centred on the maintenance and upgrade of the existing system so to ensure adequate treatment and filtration of the stormwater prior to it being discharged. The issue of infrastructure capacity was also raised.



## Part 2

### Baseline







## **4 Catchment Description**

### **4.1 Catchment Location**

The Port Chalmers catchment is a moderately steep harbour-side catchment, which covers an area of approximately 58 ha. The catchment covers the area between Sawyers Bay and Kaputau Bay, bounded roughly by the coastline of the inlet to the south, the rural area above Blueskin Road to the west, Magnetic and Constitution Streets to the east, and Beach Street in the north. To the north of the catchment there is a large area of reclaimed land which is now the location of the container port. Figure 4-1 shows the location of the Port Chalmers stormwater catchment.

Land use in the catchment is a mix of residential, rural, retail and industrial. Most of the economic activities in Port Chalmers are based around the container terminal. Historically, fishing was an important activity, but this now only has a small influence on the economy. The majority of the port activity for Otago occurs at Port Chalmers rather than central Dunedin; due to the need for deep water berths for large ships.

### **4.2 Topography and Geology**

The catchment is essentially flat surrounding the port area and becomes steeper towards the hills in the northwest. The ground levels in the Port Chalmers catchment vary between approximately 4 m and 174 m above mean sea level, with a moderately steep gradient from Sawyers Bay Inlet and the harbour towards the hills in the northwest. The elevation throughout the catchment is shown by the contours in Figure 4-2.

Figure 4-3 provides a geological map of the catchment (Bishop and Turnbull, 1996). The catchment's predominant geology is Trachyte (Md0e) and Basaltic Breccia (Md1p) which form part of the Dunedin Volcanic Group. Drainage properties of both of these geological types will depend on the extent of fractures in the rock. A smaller part of the catchment is made up of reclaimed land (Q1an). As the reclamation in this area was undertaken by the Otago Harbour Board, it is known that dredged material from the harbour was used extensively; however the extent of other types of fill, such as domestic and industrial waste, is unknown. Drainage capabilities of this material will be variable, depending on the specific materials used in different areas of the reclamation.

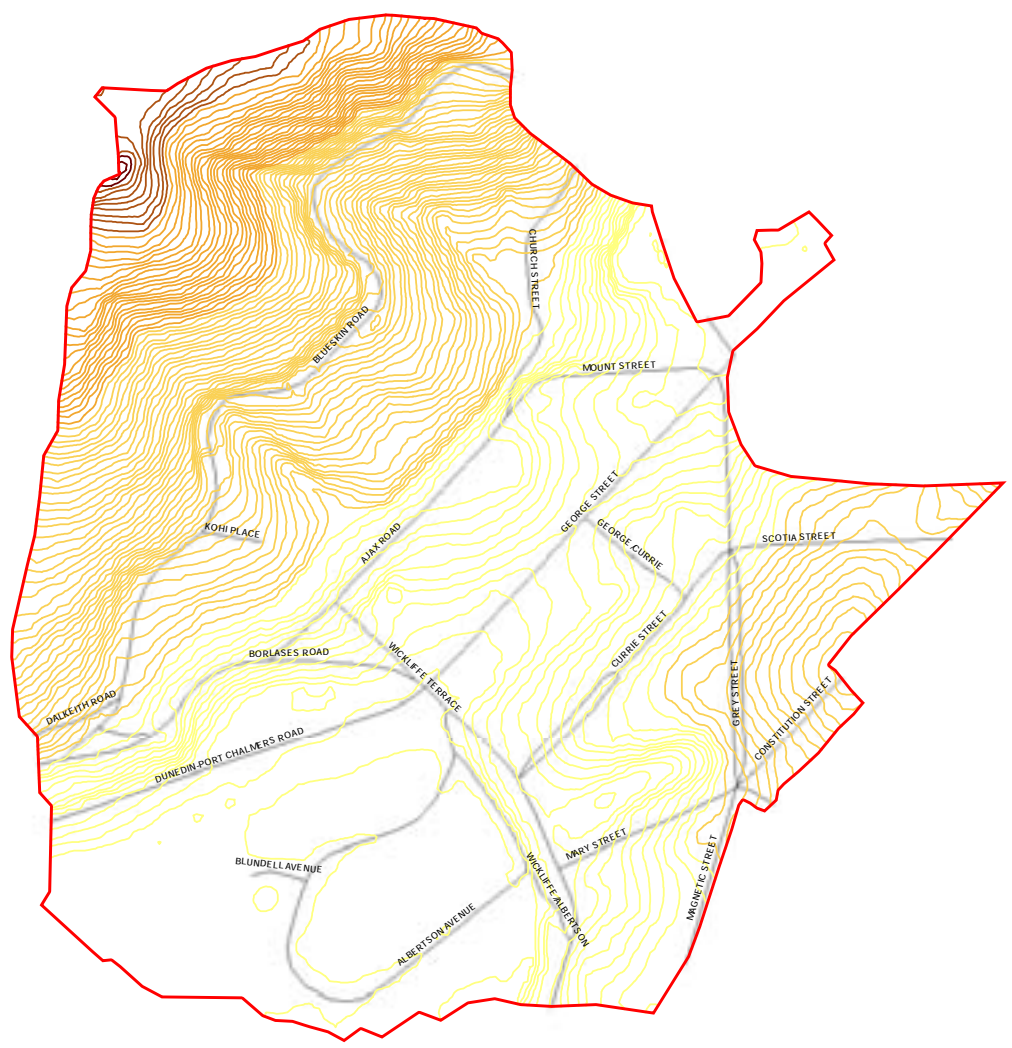
### **4.3 Surface Water**

There is no surface water or open channels included in the drainage network of this catchment.

### **4.4 Groundwater**

There is limited information relating to groundwater surface levels in the Port Chalmers catchment, and over much of the Dunedin urban area adjacent to the harbour. ORC do not currently require groundwater monitoring in the area for consent purposes. No information on groundwater quality is available, due to a lack of monitoring sites.





**Legend**

Port Chalmers Catchment Boundary

Contours (m)

<30

30-110

111-155

156-170

>170







## **4.5 Land Use**

### **4.5.1 Historical and Current Land Use**

Port Chalmers is the main port of the city. The suburb is located approximately 15 km northeast of the city centre. It is connected to Dunedin City via the railway, and State Highway 88.

The Port Chalmers area was first settled in the mid 19<sup>th</sup> century; the port was named after the Presbyterian Church leader, Thomas Chalmers. The first ships of the Otago Association settlers anchored at Port Chalmers in 1848.

Initially the area was connected to Dunedin by road, but in 1873 the first narrow gauge railway in New Zealand opened, now called the Port Chalmers Branch. Following the opening of the Victoria Ship Channel running from Port Chalmers to Dunedin, the first ship carrying refrigerated meat left Port Chalmers in 1882.

In 1971 Port Chalmers became the South Island's first container port. Container traffic has continued to grow in conjunction with the log trade and visiting cruise ships. In 1989 the borough of Port Chalmers was integrated into Dunedin City.

Currently, aside from the port area, the suburb of Port Chalmers is predominantly residential, with a population of approximately 3,000. Current land use zones are shown in Figure 4-4.

### **4.5.2 Cultural and Heritage Sites**

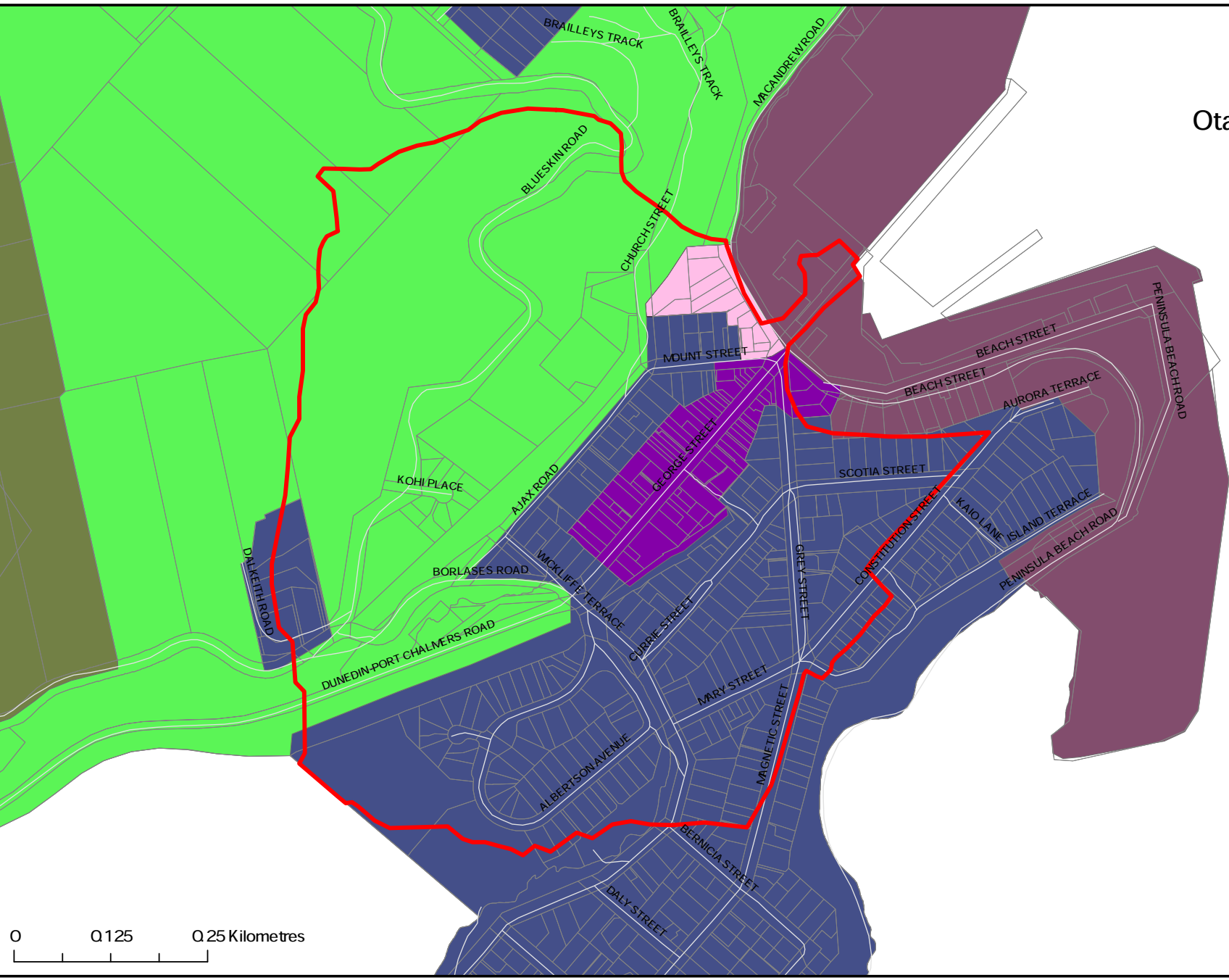
According to DCC records of significant archaeological and heritage sites within Dunedin city, heritage structures are scattered throughout the Port Chalmers catchment, however, there are no archaeological sites recorded in the District Plan.

The Port Chalmers Heritage Precinct runs the length of George Street from Beach Street to Wickliffe Terrace. Within the precinct are a number of heritage structures which include historic houses, a tavern, hotel and police station. Other heritage structures are located in the eastern portion of the catchment, and include further houses, churches, a commercial building and the Port Chalmers Masonic Hall. These are shown in Figure 4-5.

Kāi Tahu have been identified as a key stakeholder. It should be noted that coastal and freshwater environments hold particularly high values for Kāi Tahu. Māori cultural values, along with those of other stakeholders throughout Dunedin's community, are discussed in Section 3.3.



# Otago Harbour



**Legend**

Port Chalmers Catchment Boundary

Land Parcels

**District Plan Zones**

**Subzone**

CENTRAL ACTIVITY AREA

CAMPUS

INDUSTRIAL 1

INDUSTRIAL 2

LARGE SCALE RETAIL ZONE

LOCAL ACTIVITY ZONE 1

LOCAL ACTIVITY ZONE 2

PORT 1

PORT 2

RESIDENTIAL 1

RESIDENTIAL 2

RESIDENTIAL 3

RESIDENTIAL 4

RESIDENTIAL 5

RESIDENTIAL 6

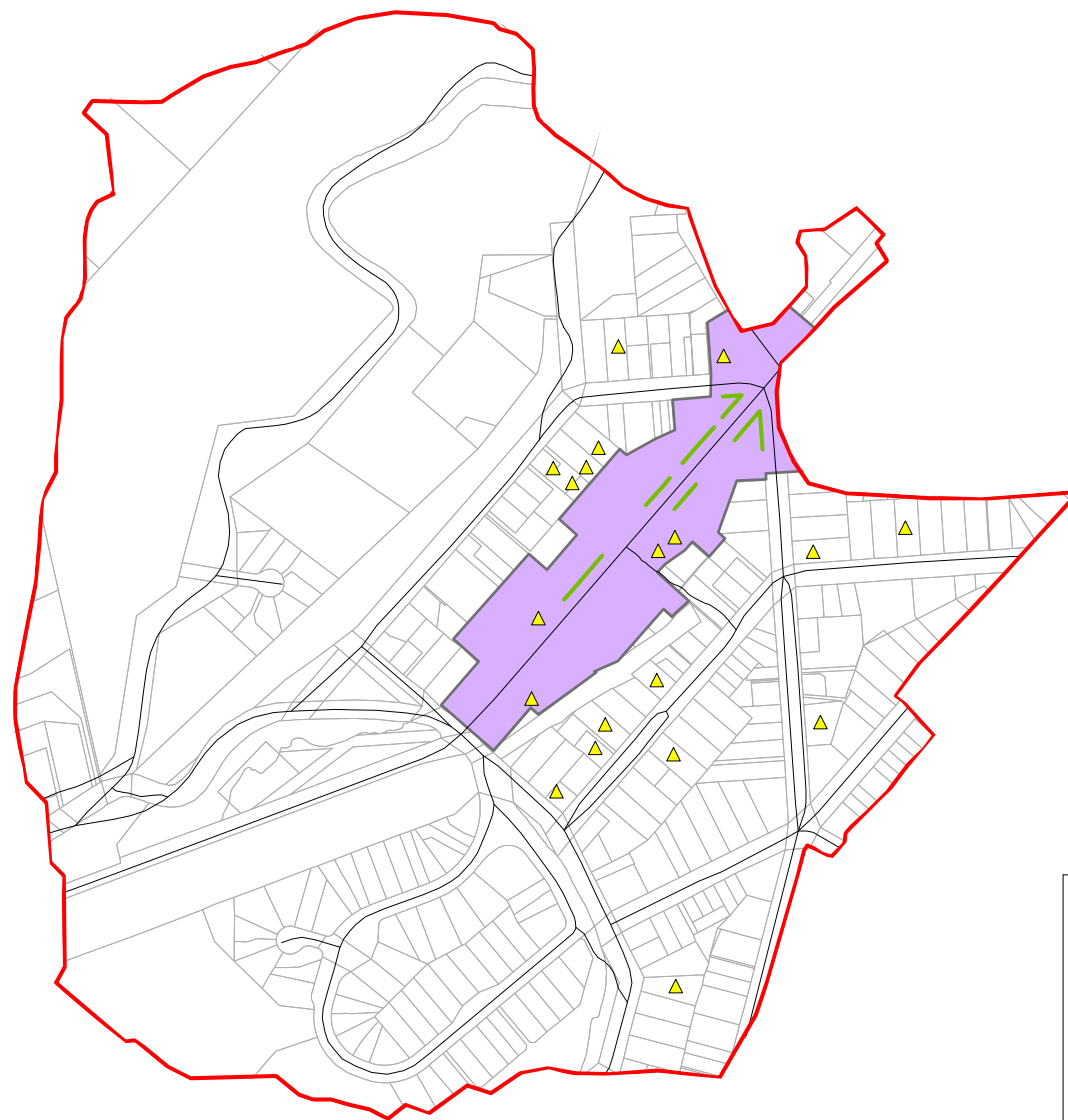
RESIDENTIAL 6A

RURAL RESIDENTIAL

RURAL

SPECIAL DEVELOPMENT





-  Catchment Boundary
-  DP Heritage Structure
-  DP Archeological Sites
-  DP Heritage Facade
-  DP Townscape and Heritage Precinct
-  Parcel Boundaries
-  Main Roads

|            |             |            |             |         |
|------------|-------------|------------|-------------|---------|
| CLAIMED BY | MG          | STATUS     | Final       |         |
| CHECKED    | LB          | BLANK      | February 11 |         |
|            |             | NTS        |             |         |
| APPROVED   | HS          | GRAND      | FILED IN    | PROCEED |
| DATE       | February 11 | 3-d1040.07 |             |         |



#### 4.5.3 Resource Consents and Designations within the Catchment

Information has been provided by ORC and DCC with respect to resource consents granted in Dunedin City and city-wide District Plan Designations.

A number of consents have been granted, by ORC and DCC, within the Port Chalmers catchment. DCC has granted a number of land use consents, the effects of which have been incorporated into the future catchment imperviousness calculations (Appendix B).

ORC has granted stormwater discharge consents, in addition to those held by DCC, in Port Chalmers. Port Otago Limited has consent to discharge stormwater from their industrial premises via 18 outfalls extending the length of their site. Whilst the Port Otago Limited site is outside the Port Chalmers catchment, their stormwater is discharged into the Upper Harbour to the north of Port Chalmers, sharing a common receiving environment with DCC stormwater discharge.

A number of District Plan Designations exist within this catchment. Several are for transport purposes and include the existing Port Chalmers Branch Railway and railway tunnel and State Highway 88, both of which run through the centre of the catchment to the port. There are also a number of other designations scattered throughout the catchment including those for education purposes, a police station and an electricity substation located on Church Street.

Figure 4-6 provides the location of the resource consents granted by DCC and District Plan designations within the Port Chalmers catchment.

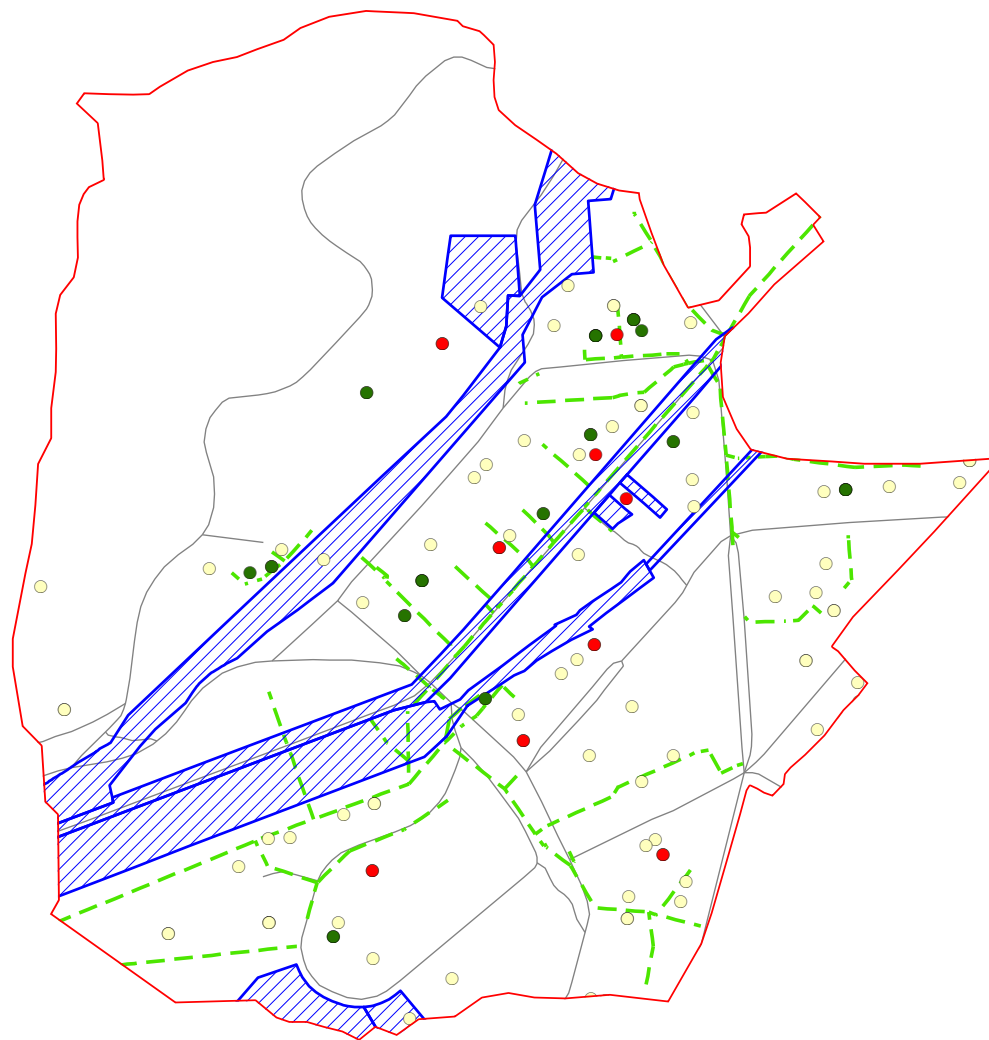
#### 4.5.4 Contaminated Land

Data was collated from both ORC and DCC with respect to contaminated land around Dunedin City. It should be noted that the information available on contaminated land sites may be incomplete and the extent of remediation is unknown in some instances.

The land in the north east and south west of the catchment has been reclaimed in conjunction with port and harbour activities. Various and unknown types of fill may have been used during land reclamation, the fill material may contain contaminants, as discussed in Section 4.2.

There are also two contaminated sites that have been identified. These comprise old gasworks, one on George Street which operated from 1871-1889, and a second that operated from 1889-1950 located adjacent to the Dunedin-Port Chalmers Road.

Figure 4-7 provides the location of the known contaminated land sites within the Port Chalmers catchment.



## Legend

Port Chalmers Catchment Boundary

### Consents

- Other Consents
- Land Use Change
- Building Consent
- Stormwater Network
- Main Roads
- District Plan Designation

0 0.2 0.4 Kilometres



Dunedin 3 Waters Strategy

## PORT CHALMERS INTEGRATED CATCHMENT MANAGEMENT PLAN

**Figure 4-6**  
Port Chalmers Catchment Recent Consents and Designations

**DISCIPLINE**  
**Stormwater**

|                |                |                     |           |
|----------------|----------------|---------------------|-----------|
| Drawn: KC      | Status: Final  |                     |           |
| Checked: HES   | Scale: 1:5,000 | Plot Date: Sep 2011 |           |
| Approved: SDH  | Job. No:       | Map No:             | Revision: |
| Date: Sep 2011 | 42173227       | Figure 4-6          | -         |





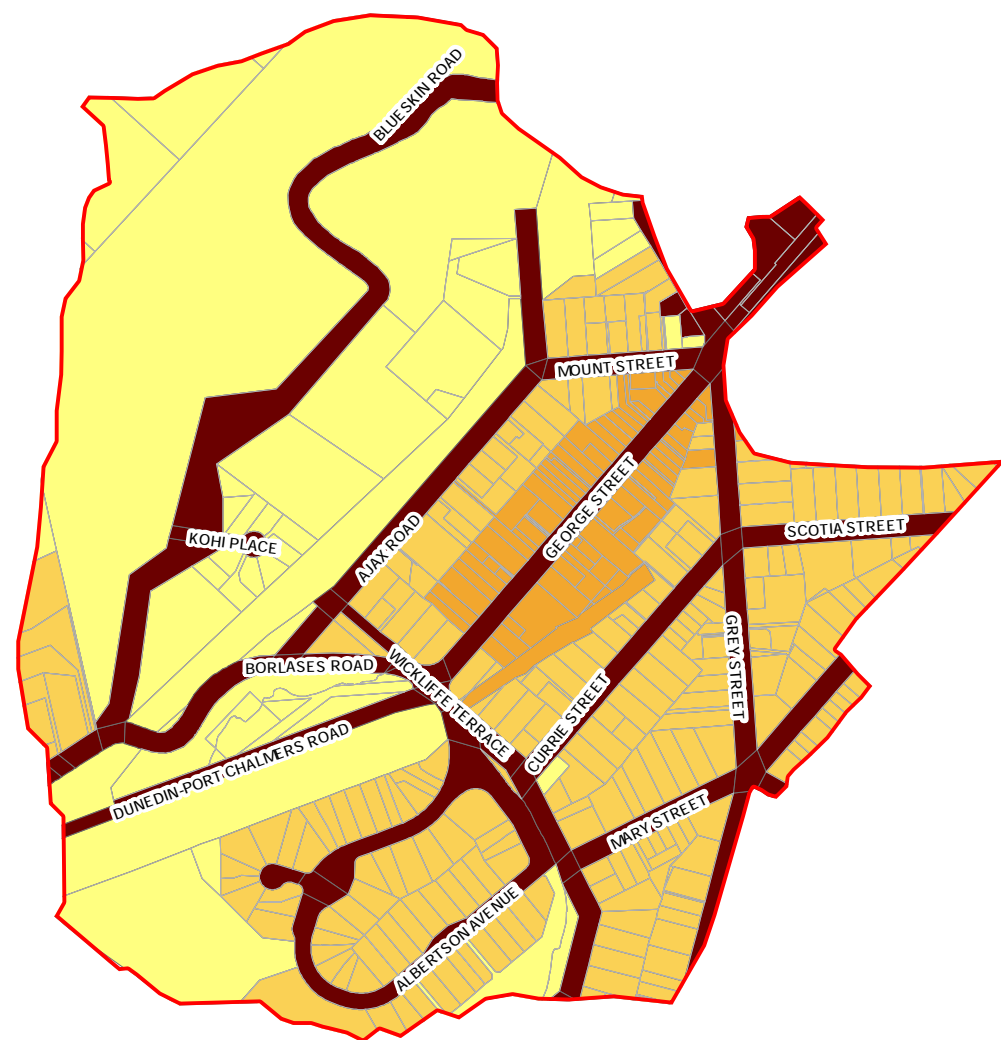
### 4.5.5 Future Land Use

Three future land use scenarios are being considered within the DCC 3 Waters Strategy along with the current situation. The scenarios are; 2008 (current), 2021, 2031 and 2060. For the purposes of stormwater modelling, the 2031 scenario contains the maximum allowable imperviousness for each zone, consistent with the planning horizon of the district plan (2036). The 2060 scenario also uses the maximum allowable imperviousness.

Approximately 65 % of the Port Chalmers catchment area is zoned rural; this is unlikely to change in the future, however it is likely that development within the rural area will occur. Currently, it is assumed to be almost entirely undeveloped. However future estimates have assumed, for example, that roads will be sealed, and some minor rural development will take place.

### 4.6 Catchment Imperviousness

Figure 4-8 provides a map of current imperviousness for the Port Chalmers catchment. Currently, the catchment is estimated to be approximately 18 % imperviousness. With allowances for increases in imperviousness within the residential and rural zones, the future imperviousness of the catchment has been estimated to be approximately 28 % (refer Appendix B for calculation methods).



### Legend

 Port Chalmers Catchment Boundary

 Land Parcels

### Current Land Use Imperviousness

Impervious (%)

-  0.0 - 20.0
-  20.1 - 40.0
-  40.1 - 60.0
-  60.1 - 80.0
-  80.1 - 100.0



Dunedin 3Waters Strategy

## PORT CHALMERS INTEGRATED CATCHMENT MANAGEMENT PLAN

Figure 4-8

Port Chalmers Catchment Current Imperviousness

DISCIPLINE  
Stormwater

|           |          |          |           |                     |
|-----------|----------|----------|-----------|---------------------|
| Drawn:    | MM       | Status:  | Final     |                     |
| Checked:  | HS       | Scale:   | 1:5,000   | Plot Date: Sep 2011 |
| Approved: | HS       | Job. No: | 421 73227 | Map No:             |
| Date:     | Sep 2011 |          |           | Revision:           |

Created with ESR ArcGIS



## 4.7 Stormwater Drainage Network

### 4.7.1 Network Description

Based on GIS (geographic information system) information, a large number of the pipe sizes are unknown (approximately 1 km out of the 4 km of pipes in the network have missing diameter data). Figure 4-9 provides the frequency distribution of the remaining pipe diameters in the Port Chalmers catchment. The data indicates that approximately half of the pipes in the catchment are fairly small, and have diameters of 150 mm and 225 mm.

Figure 4-10 provides details of the stormwater network in the catchment. The Port Chalmers stormwater system comprises three short piped sub-networks, each with a consented outfall that discharges sub-tidally; one near the port close to the end of George Street and two at the Sawyers Bay inlet.

Key network features identified during the hydraulic model construction are as follows:

- Three harbour outfalls have been included in the modelled stormwater network.
  - Outfall 1 – 900 mm x 600 mm ‘tunnel’ shaped pipe, entering the harbour beneath the wharf at the end of George Street.
  - Outfall 2 – 1250 mm diameter pipe in the south west of the catchment at Watson Park.
  - Outfall 3 – 150 mm diameter pipe adjacent to Outfall 2 at Watson Park.
- Inspection of Outfalls 1 and 3 was not possible; it is assumed that they do not have tidal flap valves. Inspection of Outfall 2 confirmed that there was no flap valve present.
- Ajax Road Intake – a deep shaft located in a low spot behind the railway, conveying flows from a nearby subdivision and any overland flows intercepted by the railway embankment.
- There are two emergency overflows to the stormwater network from the Mount Street and Mussel Bay wastewater pump stations.

The wastewater study in the area also identified a cross connection within the benching of a manhole at the intersection of Wickliffe Terrace and Albertson Avenue. This connection has since been removed (May 2011).

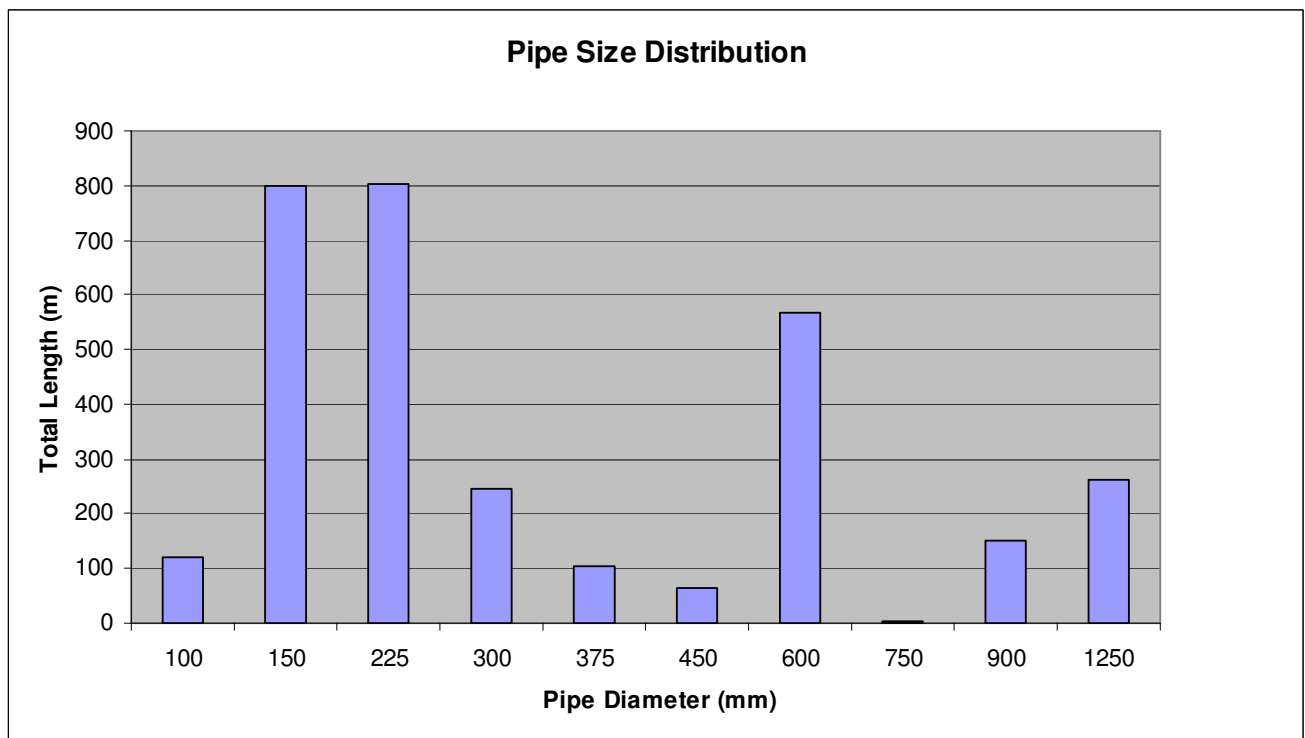
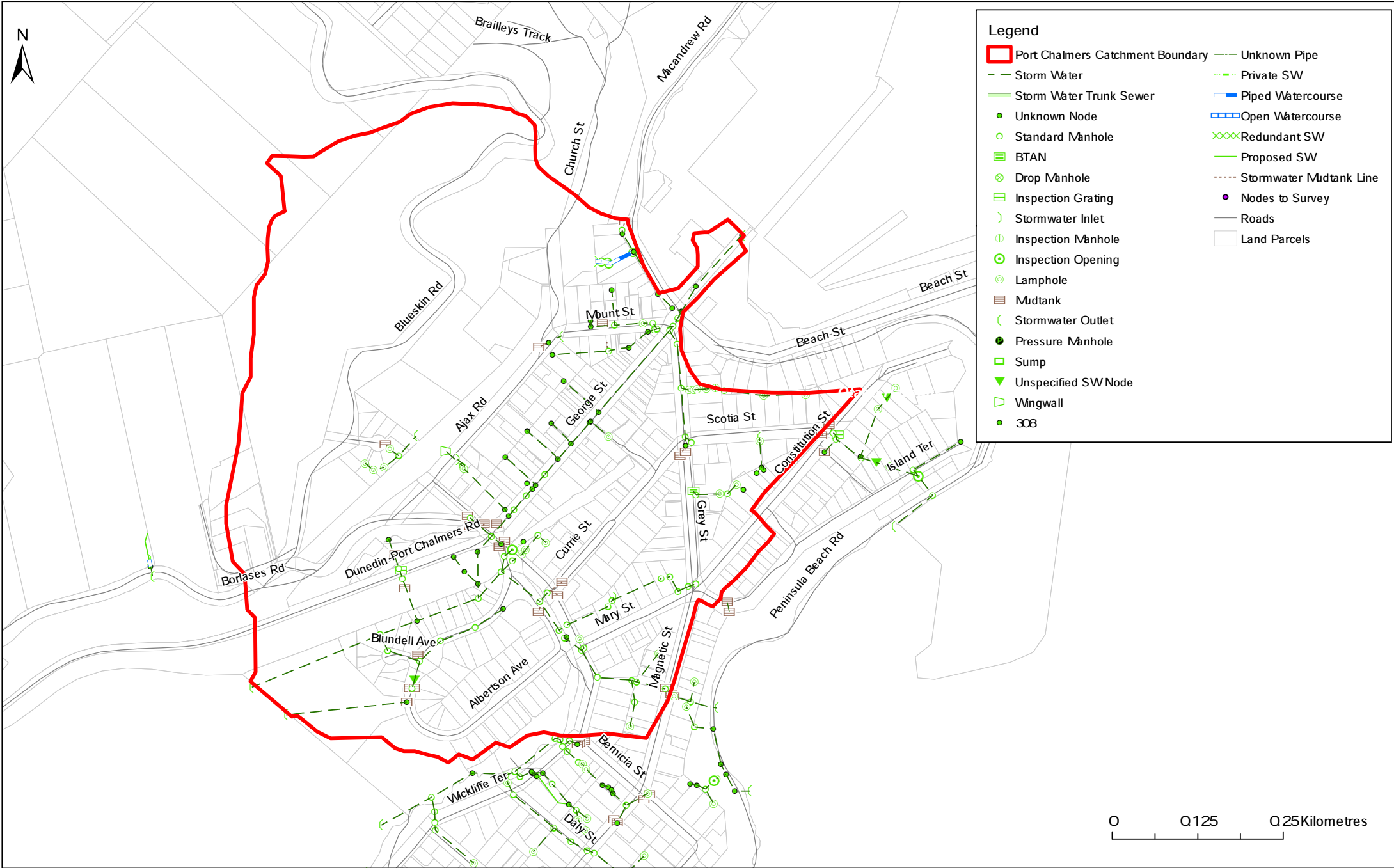


Figure 4-9: Pipe Diameter Frequency Distribution





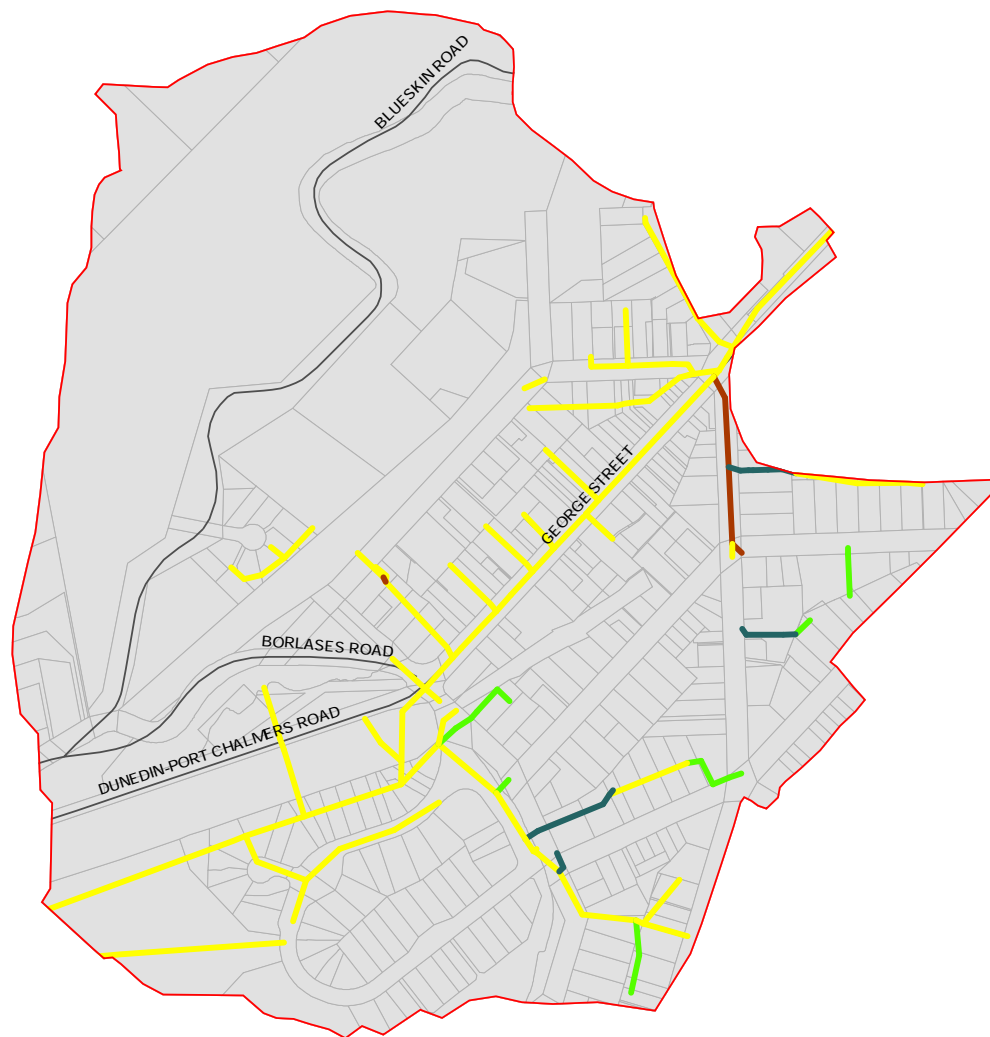
## 4.7.2 Network Age

Table 4-1 provides a breakdown of pipe age in the Port Chalmers catchment, based on information held in DCC's GIS database. Figure 4-11 provides a map of pipe age based on location. As can be seen in both the table and the map, the data indicates that the majority of the network is estimated to have been laid between 90 and 110 years ago. Discussions with DCC Network Management and Maintenance staff indicates that the original combined sewer system in Port Chalmers was separated some time ago, with part of the original system being dedicated to wastewater, and part of it to stormwater. Based on the age data, 83 % of the current stormwater system would have been the original combined network. Further doubt is cast on the information regarding pipe age when reviewing the map; areas of the Port Chalmers catchment which are modern subdivisions have estimated pipe ages of up to 100 years.

Based on the current forecasts of theoretical asset life for stormwater mains, the majority of which have been assigned a theoretical life of 100 years, 83 % of the pipe network will be subject to inspection / condition assessment or be renewed by 2060. Remaining life forecasts will be improved based on condition assessment and related work on refining expected lives, and renewals planning adjusted accordingly. Using this process, it is likely that a significant portion of the Port Chalmers catchment stormwater network will be found to be in reasonable condition upon inspection (i.e. it will not be as old as has been assumed). Therefore, it is unlikely that the portion of the Port Chalmers stormwater network to be upgraded within the next 50 years will be as high as 83 %.

**Table 4-1: Pipe Network Age and Length Composition**

| Installation Date        | Approximate Age | Number of Pipelines | Length of Pipe (m) | % of Pipe Length |
|--------------------------|-----------------|---------------------|--------------------|------------------|
| Installed 1900 or before | > 100 years     | 88                  | 3421               | 83               |
| Installed 1901 to 1920   | 90-110 years    | -                   | -                  | -                |
| Installed 1921 to 1940   | 70-90 years     | -                   | -                  | -                |
| Installed 1941 to 1960   | 50-70 years     | -                   | -                  | -                |
| Installed 1961 to 1980   | 30-50 years     | 15                  | 308                | 7                |
| Installed 1981 to 2000   | 10-30 years     | 15                  | 233                | 6                |
| Installed 2001 to 2009   | < 10 years      | 5                   | 176                | 4                |



### Legend

Port Chalmers Catchment Boundary

Land Parcels

Roads

#### Installation Year

Installed Before 1900

Installed 1901 - 1920

Installed 1921 - 1940

Installed 1941 - 1960

Installed 1961 - 1980

Installed 1981 - 2000

Installed 2001 - 2010

Roads

0 0.125 0.25 Kilometres



Dunedin 3Waters Strategy

## PORT CHALMERS INTEGRATED CATCHMENT MANAGEMENT PLAN

Figure 4-11

Port Chalmers Catchment Pipe Network Ages

DISCIPLINE  
Stormwater

|                |                    |                     |             |
|----------------|--------------------|---------------------|-------------|
| Drawn: KC      | Status: Final      |                     |             |
| Checked: HES   | Scale: 1:5,000     | Plot Date: Sep 2011 |             |
| Approved: SDH  | Job. No: 421 73227 | Map No: Figure 4-11 | Revision: - |
| Date: Sep 2011 |                    |                     |             |

Created with ESRI ArcGIS



### 4.7.3 Asset Condition and Criticality

DCC has developed and applied a first cut criticality assessment to all water, wastewater, and stormwater network assets across the city. The criticality score has been calculated based on three weighted criteria: extent, cost, and location. For the full version of the methodology used, the DCC methodology document (available on request) should be referred to. Table 4-2 summarises the first cut version used for stormwater assets as of November 2010. Note that stormwater intakes were rated slightly differently to remaining assets, with 20 % of the weighting assigned to cost and 20 % to each of the four wellbeings, given that the consequences of failure of an intake would be largely localised in nature due to area flooding.

Figure 4-12 shows a map of the Port Chalmers catchment, with criticality and the four wellbeing locations identified. This map shows pipe criticality only. Pipe condition assessment (via closed circuit television (CCTV)) is currently being undertaken throughout the city on selected pipes however, there is currently limited information available on pipes in the Port Chalmers catchment.

There are a number of wellbeing locations in the Port Chalmers catchment; with the port being a major economic location, and the railway a social location (a number of stormwater pipes cross beneath the railway). Areas in the local activity area have been identified as being minor social or economic locations, however the maximum pipe criticality assigned to pipes in the stormwater network is two.



**Table 4-2: Asset Criticality Score Criteria**

| Factor                                | Score                                                                                                                                                                               | Rating Scale                                                                                                         | Proxy Used - Pipes  | Proxy Used - Manholes             | Proxy Used - Outlets                  |
|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------------------|---------------------------------------|
| Extent (20 %)                         | 1                                                                                                                                                                                   | Insignificant function failure                                                                                       |                     |                                   | Assigned same rating as upstream pipe |
|                                       | 2                                                                                                                                                                                   | Minor (delivery) failure – Small population                                                                          | < = 600 mm diameter | Manholes on non-pressurised pipes | Assigned same rating as upstream pipe |
|                                       | 3                                                                                                                                                                                   | Major (delivery) failure – Large population                                                                          | > 600 mm diameter   | Manholes on pressurised pipes     | Assigned same rating as upstream pipe |
|                                       | 4                                                                                                                                                                                   | Major (safety, supply, containment) failure – Small population                                                       |                     |                                   | Assigned same rating as upstream pipe |
|                                       | 5                                                                                                                                                                                   | Major (safety, supply, containment) failure – Large population                                                       |                     |                                   | Assigned same rating as upstream pipe |
| Cost (20 %)                           | 1                                                                                                                                                                                   | Up to \$ 20,000                                                                                                      | All pipes           | < 3.5 m deep                      | < 3.5 m deep                          |
|                                       | 2                                                                                                                                                                                   | \$ 20,000 - \$ 150,000                                                                                               |                     | > 3.5 m deep                      | > 3.5 m deep                          |
|                                       | 3                                                                                                                                                                                   | \$ 150,000 - \$ 400,000                                                                                              |                     |                                   |                                       |
|                                       | 4                                                                                                                                                                                   | \$ 400,000 - \$ 1,000,000                                                                                            |                     |                                   |                                       |
|                                       | 5                                                                                                                                                                                   | Over \$ 1 M                                                                                                          |                     |                                   |                                       |
| Location (15 % to each of wellbeings) | 1                                                                                                                                                                                   | Within 10 m of a ‘minor’ social, environmental, cultural, or economic wellbeing location                             |                     |                                   |                                       |
|                                       | 2                                                                                                                                                                                   | Within 5 m of a ‘minor’ social, environmental, cultural, or economic wellbeing location                              |                     |                                   |                                       |
|                                       | 3                                                                                                                                                                                   | Within 10 m of a ‘major’, or within 1 m of a ‘minor’ social, environmental, cultural, or economic wellbeing location |                     |                                   |                                       |
|                                       | 4                                                                                                                                                                                   | Within 5 m of a ‘major’ social, environmental, cultural, or economic wellbeing location                              |                     |                                   |                                       |
|                                       | 5                                                                                                                                                                                   | Within 1 m of a ‘major’ social, environmental, cultural, or economic wellbeing location                              |                     |                                   |                                       |
| Weighted Criticality Score            | = (Extent Rating x 20 %) + (Cost Rating x 20 %) + (Social Rating x 15 %) + (Environmental Rating x 15 %) + (Cultural Rating x 15 %) + (Economic Rating x 15 %) = Criticality Rating |                                                                                                                      |                     |                                   |                                       |

Criticality 1 = Not Critical

Criticality 5 = Very Critical



**Legend**

**Stormwater Criticality**  
Total Criticality Score

- 1
- 2
- 3

Social Minor Location  
Social Major Location  
Economic Minor Location  
Environmental Major Location  
Cultural Location  
Economic Major Location  
Port Chalmers Catchment Boundary

0 0.05 0.1 0.2 Kilometres



Dunedin 3Waters Strategy

PORT CHALMERS INTEGRATED CATCHMENT MANAGEMENT PLAN

Figure 4-12

Port Chalmers Catchment Stormwater Network Criticality

DISCIPLINE  
Stormwater

|                |                   |                     |             |
|----------------|-------------------|---------------------|-------------|
| Drawn: MM      | Status: Final     |                     |             |
| Checked: HS    | Scale: 1:5,000    | Plot Date: Sep 2011 |             |
| Approved: HS   | Job. No: 42173227 | Map No: Figure 4-12 | Revision: A |
| Date: Sep 2011 |                   |                     |             |



#### 4.7.4 Salt Water / Saline Groundwater Intrusion

The intrusion of salt water into wastewater pipelines is a major concern for DCC, due to effects on pipe condition, and more particularly, wastewater treatment plant (WWTP) processes.

In terms of the stormwater system, salt water intrusion via the outfall pipes occurs regularly, however ingress of saline groundwater along the pipelines could further reduce the capacity of the network during high tides.

An investigation by Van Valkengoed & Wright (2009) examined the regions adjacent to the Otago Harbour and highlighted the key locations where salt water is entering the wastewater system. This investigation did not, however, examine the stormwater system, and concentrated on the Upper Harbour Basin. As such, the extent of saline groundwater intrusion into the stormwater network in the Port Chalmers catchment is unknown. Tidal influence on the system via the harbour outfalls is discussed further in Section 8.

#### 4.7.5 Operational Issues

Discussions were held with DCC operations personnel during the catchment walkover (November 2009) in order to identify known operational issues or locations of historical flooding. Further discussions were held during a workshop with DCC Water and Waste Business Unit staff in March 2011.

During the initial phases of the investigations, including the catchment walkovers, no serious issues were highlighted by DCC staff.

Further workshop discussions highlighted the following issues:

- Shallow flooding of the road in Albertson Avenue;
- Flooding at the George Street / Wickliffe Terrace intersection; and
- Ponding in the kerb of Beach Street.

#### 4.7.6 Network Maintenance and Cleaning

The maintenance of catchpits is perceived to be a general issue across Dunedin City according to the Water and Waste Business Unit. It was noted by the Network Management and Maintenance team that during autumn months heavy rainfall can result in blocked catchpits or inlet screens regardless of how well maintained they are. Failure to remove silt and gravel from the catchpits can also lead to siltation and hence capacity reduction of the pipe network; siltation has been identified as an issue in some areas of Dunedin by the Network Management and Maintenance team, and this is currently being investigated as part of a city-wide CCTV programme.

The responsibility for the cleaning and maintenance of stormwater catchpits and other structures is divided between three DCC departments: Network Management (Water and Waste Business Unit), Transportation Operations and Community and Recreation Services (CARS).



### Network Management

Stormwater structures under Network Management and Maintenance team supervision are inspected on a weekly basis, after a rainfall event and before forecast bad weather. The specification for these inspections is as follows:

- Check access to the site in respect to Health and Safety requirements.
- Check the screen intake to ensure screen is 95 % or more clear.
- Check upstream channel is clear of debris (approximately first 5 m).
- Check for any recent signs of overflow since last visit.
- If debris blocking intake screen, remove to achieve 95 % clearance. Type of material and approximate volume and weight to be recorded on the Screen / Intake Checklist.

In addition to the weekly inspections, condition assessments are completed every six months.

### Transportation Operations

DCC Transportation Operations are responsible for stormwater structures within the road reserve (except State Highway, which are the responsibility of the New Zealand Transport Agency (NZTA)).

The cleaning and maintenance of these structures is contracted to a main contractor, managed by Transportation Operations. The main contractor then subcontracts the work to a third party.

Under the Transportation Operations cleaning and maintenance contract, with the main contractor, the asset cleaning and frequency levels of service are listed as follows:

- At any time at least 95 % of mud tanks shall have available 90 % of their grate waterway area clear of debris.
- At least 95 % of mud tanks, catchpits and sumps shall have at least 150 mm below the level of the outlet invert clear of debris.
- At least 95 % of culverts shall have at least 90 % of their waterway area clear of debris throughout the entire length of the structure including 5 m upstream and downstream.
- At least 90 % of all other stormwater structures shall have 90 % of the waterway area clear of debris.

Included in the contract is an initial six month cycle to bring all stormwater structures up to specification. Once up to specification, they must be maintained to the specified level of service. Information relating to the way that compliance with the required level of service is measured was unavailable.

The cleaning and maintenance of stormwater structures in the road is currently perceived by Water and Waste Business Unit maintenance team to be inadequate. DCC have concerns that the cleaning and maintenance contract is not specific enough and therefore the stormwater structures within the roads are not maintained to a satisfactory standard.



### Community and Recreation Services

The maintenance and cleaning of stormwater structures located within parks and reserves, other than those listed under Network Management and Maintenance team supervision, are the responsibility of CARS.

At the time of writing this plan, CARS did not have a maintenance schedule for stormwater structures within parks and reserves. They were unable to confirm the location of such stormwater structures or whether any existed within the parks and reserves.

### **4.8 Customer Complaints**

Based on DCC customer complaints information collated between 2005 and 2010, there were approximately ten recorded stormwater complaints during this time in the Port Chalmers catchment that relate to blockages, leakages or overflows, or that are unspecified. These are mapped as Figure 4-13. The complaints recorded do not appear to show any particular pattern or area of concern, however model calibration results correlated well with flooding complaints received in the following areas:

- Albertson Avenue;
- Wickliffe Terrace;
- George Street; and
- Beach Street.

Wastewater customer complaints information compiled between 2005 and 2010 are indicated in Figure 4-14. These complaints are also spread across the catchment, however locations on Wickliffe Terrace and Mary Street have reported issues on more than one occasion. It is not known however, if these issues were within private properties or within the DCC wastewater system.

Legend

Port Chalmers Catchment Boundary

Land Parcels

Stormwater Flooding Complaints

Year

Undated

2005

2006

2007

2008

2009

2010

Exact Location Known (Full Address)

Problem Description

Complaints

Floodgate Outlet Damaged

Pollution Spill

Stormwater Channel Screen Blocked

Stormwater Channel Screen Damaged

Stormwater Overflowing - Into my basement or garage

Stormwater Overflowing - Onto my property

Drain - Boundary trap overflow

Lamphole - Overflowing

Sewer Blocked

Sewer Collapsed

Sewer Leaking

Sewer Overflowing

Sewer Manhole - Overflowing

Exact Location Unknown (Road Name Only)

Problem Description

Complaint

Stormwater Channel Screen Blocked

Stormwater Channel Screen Damaged

Stormwater Overflowing - Into my basement or garage

Stormwater Overflowing - Onto my property

Sewer Blocked

Sewer Leaking

Sewer Overflowing

Sewer Manhole - Overflowing



## Legend

Port Chalmers Catchment Boundary

Land Parcels

## Wastewater Complaints

Year

- 2006
- 2007
- 2008
- 2009
- 2010

## Exact Location Known (Full Address)

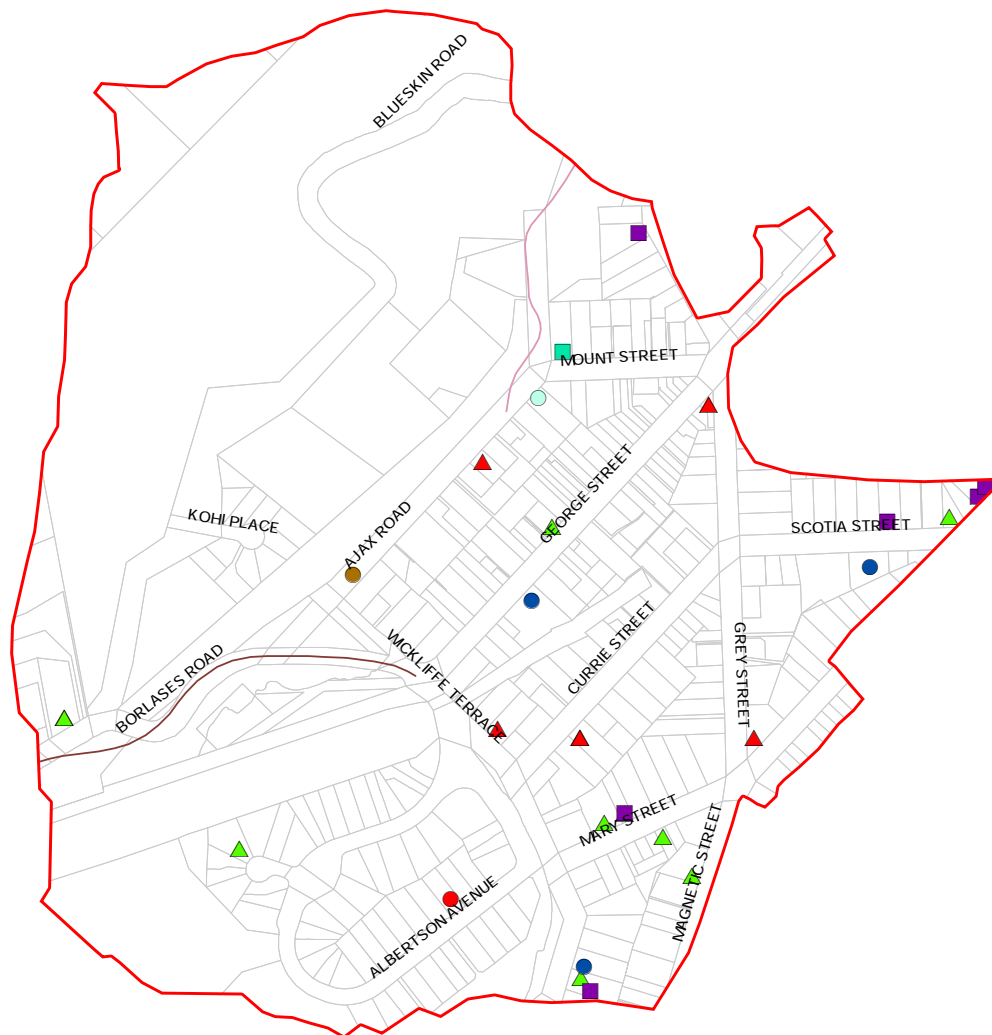
Problem Description

- Foul Drain - Boundary Trap Overflow
- Foul Sewer - Blocked
- Foul Sewer - Broken
- Foul Sewer - Collapsed
- Foul Sewer - Complaint - Service Other
- Foul Sewer - Drain Gully Trap Overflow
- Foul Sewer - Overflowing
- Foul Sewer - Problem, Other
- Foul Sewer - Lamphole Overflowing
- Foul Sewer - Manhole Overflowing
- Foul Sewer - Overflowing Inside My House
- Foul Sewer - Pump Station Overflowing

## Exact Location Unknown (Road Name Only)

Problem Description

- FOUL DRAIN - BOUNDARY TRAP OVERFLOW
- FOUL SEWER - BLOCKED
- FOUL SEWER - BROKEN
- FOUL SEWER - COLLAPSED
- FOUL SEWER - COMPLAINT - SERVICE OTHER
- FOUL SEWER - DRAIN GULLY TRAP OVERFLOW
- FOUL SEWER - OVERFLOWING
- FOUL SEWER - PROBLEMOTHER
- FOUL SEWER MANHOLE - OVERFLOWING
- FOUL SEWER PUMP STATION - OVERFLOWING



0 0.125 0.25 Kilometres



Dunedin 3Waters Strategy

## PORT CHALMERS INTEGRATED CATCHMENT MANAGEMENT PLAN

Figure 4-14

Port Chalmers Catchment Reported Wastewater Flooding

DISCIPLINE  
Stormwater

|                |                    |                     |             |
|----------------|--------------------|---------------------|-------------|
| Drawn: KC      | Status: Final      |                     |             |
| Checked: HES   | Scale: 1:5,000     | Plot Date: Sep 2011 |             |
| Approved: SDH  | Job. No: 421 73227 | Map No: Figure 4-14 | Revision: - |
| Date: Sep 2011 |                    |                     |             |



## **4.9 Water and Wastewater Systems**

Figure 4-15 provides a layout of the three waters networks in the Port Chalmers catchment.

Both the wastewater and water networks have been studied at a macro scale as part of the 3 Waters Strategy Phase 1, and in more detail during Phase 2. Section 12 further discusses modelling work undertaken on the water and wastewater systems throughout the city. Issues discovered in the Port Chalmers catchment during Phase 1 and 2 are highlighted below.

### **4.9.1 Water Supply System**

The Dunedin water supply network was investigated for Phase 1 at a distribution mains level only, with further investigations focussing on key areas during Phase 2. A raw water study investigated the sources and reliability of water supply to the city.

The results indicated that the Dunedin water supply distribution (trunk mains) network provides sufficient treated water capacity and raw water storage, on a daily and weekly basis, to meet peak summer demands. It is recognised that there is a lack of strategic raw water storage during severe drought conditions.

The Dunedin water supply network receives treated water from the Mount Grand WTP to the north west of the city and the Southern WTP to the south west of the city. A number of sources supply raw water to the WTPs. Treated water from the WTPs is supplied to the city primarily by gravity, with the distribution mains, reservoirs and pressure reducing valves controlling the pressure and flow to most of the water supply zones in the city. A number of pump stations are also required to boost water pressure to reservoirs at high points or at the extremities of the system.

The water for the Port Chalmers catchment is supplied from the Port Chalmers reservoir, located to the north of the catchment. There are approximately 5 km of water supply pipes within the Port Chalmers catchment, most of which are less than 200 mm in diameter. The majority of the supply pipes in this catchment are constructed from cast iron.

The key issue for the water supply in this catchment is pumping sufficient water from the St Leonards reservoir to the Port Chalmers reservoir, without dropping pressures too much for the high level properties upstream of the pump station. The Port Chalmers area can have high demand for treated water, particularly when cruise ships are taking water from the port.

Leakage in Port Chalmers has been identified as marginally higher than the Dunedin average.

### **4.9.2 Wastewater System**

The main areas of investigation into the Dunedin City wastewater system for Phase 1 were system capacity, hydraulic performance, wastewater overflows and pumping stations. Current and future anticipated issues within the system at a macro level were identified. Flow survey and modelling from Phase 1 revealed a strong wet weather influence on the wastewater system city-wide, caused by both direct and indirect entry of stormwater via storm induced inflow and infiltration (I&I). A number of manhole overflows were also predicted by the modelling whereby wastewater may then enter the stormwater system via kerb and channel and stormwater sumps and contribute to stormwater flows. Investigations also revealed that a number of wastewater overflows to the natural environment have been found to operate during rainfall events within Dunedin City.

The Dunedin City wastewater system collects wastewater from commercial, industrial and residential customers in Dunedin City. It is split into three distinct schemes, the Dunedin Metropolitan Scheme, the Mosgiel Scheme and the Green Island Scheme.



The wastewater system within the Port Chalmers catchment is part of the Dunedin Metropolitan Scheme. The Metropolitan Scheme provides wastewater services to the urban area of Dunedin, West Harbour communities, Ocean Grove and the Peninsula down to Portobello. The main interceptor sewer (MIS) is the main sewer line that collects wastewater flows from the Metropolitan Scheme. It conveys flows to the pump station at Musselburgh where they are then pumped to the Tahuna WWTP. The MIS extends from the Harrow Street / Frederick Street intersection in the city centre to the Musselburgh pump station.

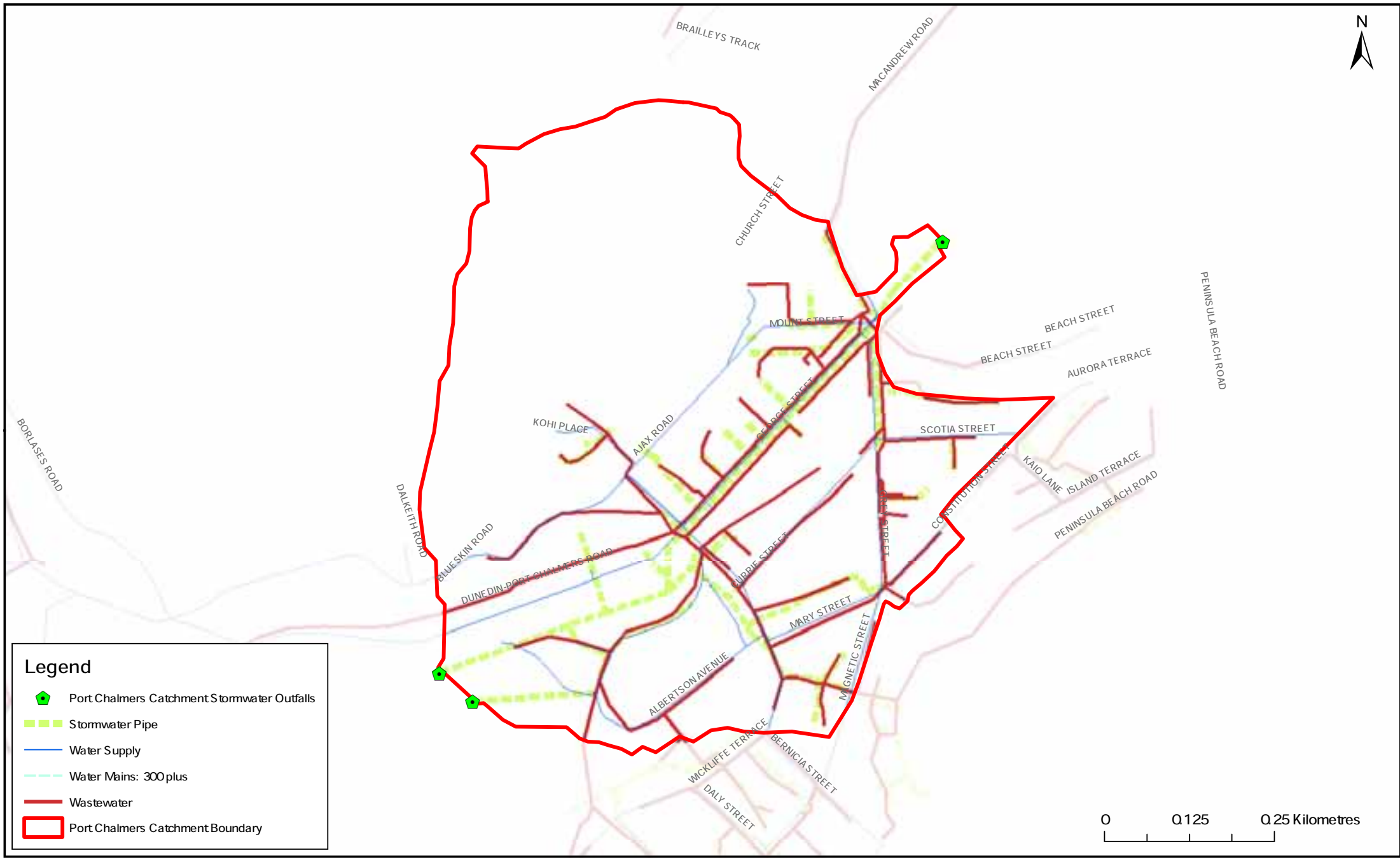
The system within the Port Chalmers catchment comprises approximately 6 km of wastewater pipeline, approximately 88 % of which are between 150 mm and 300 mm in diameter.

Flows from the Port Chalmers catchment are conveyed to Mussel Bay pump station either directly or indirectly via the Mount Street pumping station. From Mussel Bay pump station they are conveyed via a series of transfer pump stations to the MIS.

Both the Mussel Bay and Mount Street pump stations have emergency overflows to the stormwater system which may operate due to pump failure or when wastewater flows exceed the pump rate. Frequency analysis carried out during Phase 2 of the 3 Waters Strategy Project indicated that the emergency overflows of both pump stations are unlikely to operate unless extreme rainfall events are experienced (> 1 in 50 yr Average Recurrence Interval (ARI)) or there are pump failures. Furthermore, DCC Water and Wastes Services staff confirmed that there were no known instances of emergency overflow operation in the recent past.

I&I problems within the Port Chalmers catchment contribute to increased flows to the Sawyers Bay pumping station downstream of this catchment. The majority of the increased flows however, result from the Sawyers Bay wastewater catchment, downstream of Port Chalmers. The increased flows, due to I&I, result in significant overflows from the Sawyers Bay pump station to the adjacent Sawyers Bay. It should be noted that this occurs outside (downstream) the Port Chalmers stormwater catchment. At the time of writing this report, solutions to reduce the number of overflows from the Sawyers Bay pump station are being developed.

The 3 Waters Strategy Project wastewater study did not identify any significant issues with the wastewater system within the Port Chalmers catchment.



**Legend**

- Port Chalmers Catchment Stormwater Outfalls
- Stormwater Pipe
- Water Supply
- Water Mains: 300plus
- Wastewater
- Port Chalmers Catchment Boundary



|              |                          |                                                                                                                                                            |                                                          |                |                   |                     |
|--------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------|-------------------|---------------------|
| <div> </div> | Dunedin 3Waters Strategy | <div> <div>PORT CHALMERS INTEGRATED CATCHMENT MANAGEMENT PLAN</div> <div>Figure 4-15</div> <div>Port Chalmers Catchment Three Waters Networks</div> </div> | <div> <div>DISCIPLINE</div> <div>Stormwater</div> </div> | Drawn: KC      | Status: Final     |                     |
|              |                          |                                                                                                                                                            |                                                          | Checked: HES   | Scale: 1:5,000    | Plot Date: Sep 2011 |
|              |                          |                                                                                                                                                            |                                                          | Approved: SDH  | Job No: 421 73227 | Map No: Figure 4-15 |
|              |                          |                                                                                                                                                            |                                                          | Date: Sep 2011 |                   | Revision: -         |



## 5 Receiving Environment

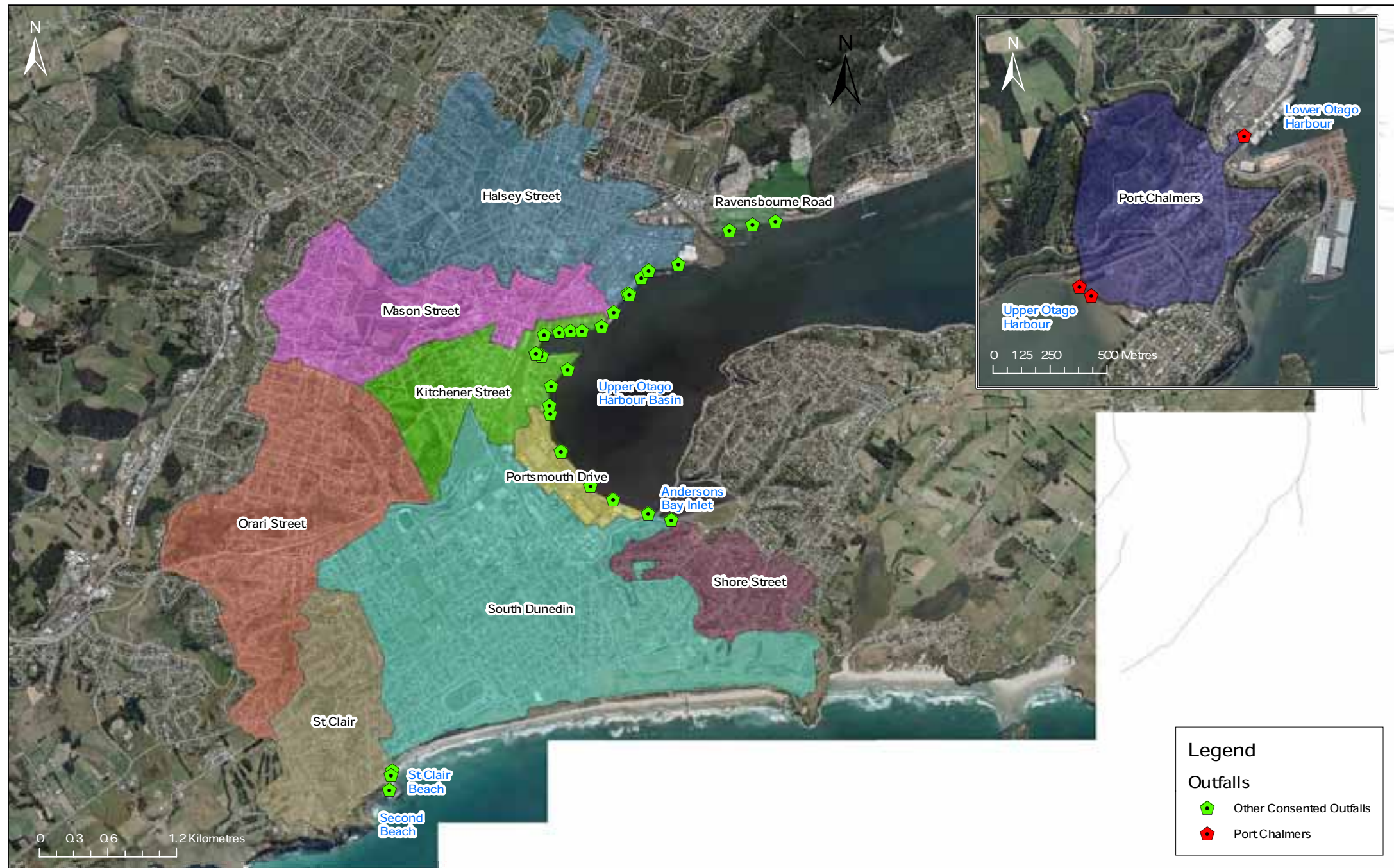
This section identifies and describes the stormwater receiving environment for the Port Chalmers catchment. An overview of the quality and value of the receiving environment is provided, acknowledging that both historical and current stormwater management, as well as many other activities not related to stormwater management within the catchment, have contributed to the state of this environment.

Part 3 of this report identifies and analyses the effects that specific stormwater management practices are considered to be having on the receiving environment of the catchment. Where the effects are considered to be unacceptable, options for avoiding, remedying or mitigating the effects are discussed in Part 5 of this report.

The stormwater network in the Port Chalmers catchment discharges directly to the marine environment at the north-eastern shore of the Otago Harbour via three outfalls. Two outfalls at Watson Park discharge stormwater from a predominantly residential / commercial portion of the catchment, with the railway running through it, draining to Sawyers Bay within the Upper Harbour. The third, George Street outfall, discharges stormwater from the industrial / commercial portion of the catchment into deep water within the Lower Harbour at the port.

The location of the outfalls, relative to other DCC stormwater outfalls and the Otago Harbour receiving environment, is shown in Figure 5-1.

There are no natural streams in the Port Chalmers catchment.



|                                                                                                                                                                                                                                                                     |                          |                                                      |                              |                |                   |                     |             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------------------------------------------------------|------------------------------|----------------|-------------------|---------------------|-------------|
| <div></div> | Dunedin 3Waters Strategy | PORT CHALMERS INTEGRATED CATCHMENT MANAGEMENT PLAN   | DISCIPLINE<br><br>Stormwater | Drawn: MM      | Status: Final     |                     |             |
|                                                                                                                                                                                                                                                                     |                          | Figure 5-2                                           |                              | Checked: HES   | Scale: 1:30000    | Plot Date: Sep 2011 |             |
|                                                                                                                                                                                                                                                                     |                          | Port Chalmers Catchment Marine Receiving Environment |                              | Approved: HES  | Job. No: 42173227 | Map No: Figure 5-2  | Revision: - |
|                                                                                                                                                                                                                                                                     |                          |                                                      |                              | Date: Sep 2011 |                   |                     |             |



## 5.1 Marine Receiving Environment

Monitoring of the Upper Harbour environment is undertaken on an annual basis in accordance with the conditions of resource consent for DCC's stormwater discharges. To date, four rounds of monitoring have been undertaken (2007, 2008, 2009, and 2010). The majority of this monitoring has been carried out in the Upper Harbour basin close to the city and little monitoring has been carried out in the Port Chalmers catchment receiving environment.

The annual monitoring in the Otago Harbour involves biological, sediment and stormwater monitoring, and while intended to identify the effects of stormwater discharges, as noted above, may be measuring the effects of historical contamination (particularly in the case of sediment monitoring where annual deposition rates are thought to be low), as well as the effects of other contaminant sources other than stormwater:

There have been a number of studies carried out to establish the condition of the Otago Harbour receiving environment. A study of Dunedin's marine stormwater outfalls was completed in 2010 by Ryder Consulting Ltd. (Ryder, 2010a), for the purpose of assessing the current quality of the receiving environments and the potential effects of stormwater on the environments. This study comprises an assessment of the stormwater, sediments, and ecology in the vicinity of the major outfalls within the harbour using sites and methods generally in accordance with those carried out for the annual monitoring. The results of this study were compared with past surveys and historical data in order to determine the condition of the harbour receiving environment.

The following reports are provided for reference in Appendix C:

- Ryder (2010a) Ecological Assessment of Dunedin's Marine Stormwater Outfalls.
- Ryder (2010b). Compliance Monitoring 2010. Stormwater Discharges from Dunedin City.
- Ryder (2010c). Dunedin Three Waters Strategy Stream Assessments.
- Ryder (2009). Compliance Monitoring 2009. Stormwater Discharges from Dunedin City.
- Ryder (2008). Compliance Monitoring 2008. Stormwater Discharges from Dunedin City.
- Ryder (2007). Compliance Monitoring 2007. Stormwater Discharges from Dunedin City.
- Ryder (2006). Remediation of Contaminated Sediments off the South Dunedin Stormwater Outfall: A proposed course of action.
- Ryder (2005a). Characterisation of Dunedin's Urban Stormwater Discharges & Their Effect on The Upper Harbour Basin Coastal Environment.
- Ryder (2005b). Spatial Distribution of Contaminants in Sediments off the South Dunedin Stormwater Outfall.



### 5.1.1 Otago Upper Harbour

Two of the stormwater outfalls from the Port Chalmers catchment discharge into the Otago Upper Harbour at Sawyers Bay, the third discharges into the Lower Harbour to the north of the catchment in the port area.

The Upper Harbour extends from Goat and Quarantine Islands to the mouth of the Water of Leith. The long narrow shape of the Upper Harbour creates strong tidal flows with the residence time of the water being variable depending on location (ORC, 1998).

Stormwater is received from the greater Dunedin urban area and surrounding rural catchments and discharged via outfalls into the Otago Harbour at a number of locations, shown in Figure 5-1. The locations of the discharges from Port Chalmers are over eight kilometres to the north east of the majority of the DCC stormwater outfalls which discharge into the Upper Harbour Basin (adjacent to the main urban zone of Dunedin City).

The majority of studies carried out in the Otago Harbour have concentrated on the Upper Harbour Basin area, and as such information relating to the Upper Harbour environment in the vicinity of the Port Chalmers outfalls is limited.

### 5.1.2 Recreational and Cultural Significance

The harbour is considered an important area for recreation. It is frequently used by wind surfers, fishers and hobby sailors and there are yacht and rowing clubs in Port Chalmers.

Port Chalmers is also an important location for tourism with many cruise ships berthing in the port each year and a number of tourism companies operating in the area.

The CIA undertaken by KTKO Ltd. (2005), relating to the initial applications for consent by DCC, to discharge stormwater into the marine environment, describes the strong relationship that Kāi Tahu ki Otago have with the coastal environment. Evidence of Māori use of the harbour extends back to Māori earliest tribal history when the harbour was a valued food resource and used for transport. The report states that the increasing degradation of the harbour environment has affected Māori in many ways and its place as a mahika kai had been dramatically altered. Further consultation with Kāi Tahu is discussed in Section 3 of this report.

### 5.1.3 Harbour Ecology

The biological investigations undertaken to date as part of DCC annual monitoring for resource consents look at the effects of the presence / absence of particular stormwater associated contaminants on the ecological communities of the harbour. The diversity of benthic flora and fauna is generally accepted as a reasonable indicator of environmental health. The presence of pollution tolerant species, and an absence of pollution intolerant species, can be used to indicate contamination. However, significant amounts of data are required to link the presence or absence of indicator species with contamination. Table 5-1 provides typical sources of urban stormwater contaminants.

Harbour ecology is likely to be affected by a number of other factors including other discharges, freshwater input to the harbour and historical sediment contamination.



The resource consents associated with the outfalls of the Port Chalmers catchment do not have any conditions requiring biological monitoring. However, some ecological assessment has been carried out in the past in the Port Chalmers area and the 2010 study carried out by Ryder Consulting Ltd. included a biological assessment of the Watson Park outfalls to the south-west of the catchment.

**Table 5-1: Sources of Stormwater Contaminants**

| Contaminant                                            | Potential Sources                                                                                                                                                              |
|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Total Suspended Solids (TSS)                           | Erosion, including stream-bank erosion. Can be intensified by vegetation stripping and construction activities.                                                                |
| Arsenic (As)                                           | Naturally occurring in soils / rocks of New Zealand; combustion of fossil fuels; industrial activities, including primary production of iron, steel, copper, nickel, and zinc. |
| Cadmium (Cd)                                           | Zinc products (Cd occurs as a contaminant), soldering for aluminium, ink, batteries, paints, oils spills, industrial activities.                                               |
| Chromium (Cr)                                          | Pigments for paints & dyes; vehicle brake lining wear; corrosion of welded metal plating; wear of moving parts in engines; pesticides; fertilisers; industrial activities.     |
| Copper (Cu)                                            | Vehicle brake linings; plumbing (including gutters and downpipes); pesticides and fungicides; industrial activities.                                                           |
| Nickel (Ni)                                            | Corrosion of welded metal plating; wear of moving parts in engines; electroplating and alloy manufacture.                                                                      |
| Lead (Pb)                                              | Residues from historic paint and petrol (exhaust emissions), pipes, guttering & roof flashing; industrial activities.                                                          |
| Zinc (Zn)                                              | Vehicle tyre wear and exhausts, galvanised building materials (e.g. roofs), paints, industrial activities.                                                                     |
| Polycyclic aromatic hydrocarbons (PAHs)                | Vehicle / engine oil; vehicle exhaust emissions; erosion of road surfaces; pesticides.                                                                                         |
| Faecal coliforms / E.coli                              | Animals (birds, rodents, domestic pets, livestock), sewage.                                                                                                                    |
| Fluorescent Whitening Agents (FWAs)                    | Constituent of domestic cleaning products, indicator of human sewage contamination.                                                                                            |
| References: ARC (2005); ROU (2007); Williamson (1993). |                                                                                                                                                                                |

An environmental impact assessment was carried out as part of Port Otago's reclamation programme, a component of which included an analysis of the marine ecology in the area (Probert 1990a, 1990b). The relevant findings can be summarised as follows:

- Benthic communities in and around Port Chalmers are generally similar to those of mud bottoms throughout the Otago Harbour.
- The intertidal zone around Port Chalmers appears to harbour organisms similar to other rocky shore communities within Otago Harbour.



- Rocky shore communities around Port Chalmers are more diverse than in the Upper Harbour Basin but less diverse than those further out in the harbour and on naturally occurring rocky shores.

The assessments carried out for the 2010 study were limited by the substrates in the vicinity of the outfalls. No assessment was carried out at the George Street outfall as this discharges into deep water. At the Watson Park outfalls, it was not possible to survey infauna as any suitable substrate was deemed to be too far away from the outfalls to be directly influenced by the stormwater discharges. The study results can be summarised as follows:

- Macroalgae was virtually absent.
- Epifauna was moderately abundant, dominated by barnacles, and was higher closer to the outfalls. Diversity of epifauna was relatively low.

As the outfalls for the Port Chalmers catchment are not in locations with a suitable environment to adequately assess the ecology, there is a lack of data available relating to the Port Chalmers catchment. It is therefore not possible to identify any clear trends in the state of the ecology in the receiving environment.

### 5.1.4 Harbour Sediments

The Upper Harbour bed has been classified, in general, as muddy sands / sandy muds, with varying proportions of fine gravels (Ryder, 2005).

In the Port Chalmers catchment, the George Street outfall discharges into deep water within the port. Sediments in this location are generally composed of fine muds (Probert, 1990a). The Watson Park outfalls discharge stormwater to Sawyers Bay, the substrate in this location comprises muds, fine and coarse sand and small gravels (Ryder, 2010a).

The resource consents associated with the Port Chalmers catchment outfalls do not have any sediment monitoring requirements. However, sediments were collected and analysed from within 5 m and greater than 20 m from these outfalls for the 2010 study.

The influence of other discharges from a variety of other activities, both current and historical, are expected to be evident in harbour sediments at this location, and throughout the upper harbour in particular around the George Street outfall in the port. There are a further 18 outfalls discharging stormwater from the port sub-catchment into the same receiving environment as the DCC George Street outfall. The consents for these discharges are held by Port Otago Limited.

Some historic data is available regarding contamination in the sediments of the Port Chalmers catchment. However, historic values should be viewed with caution as sampling in previous years may have used different protocols and sediments may have been collected from different substrate depths and by different methods.

The sediment analysis results for the 2010 study are presented in Table 5-2 alongside Australian and New Zealand Environment and Conservation Council (ANZECC, 2000) sediment quality guidelines and are discussed below.

ANZECC (2000) sediment quality guidelines provide low and high trigger values. The low values are indicative of contaminant concentrations where the onset of adverse biological effects may occur, thus providing early warning and the potential for adverse environmental effects to be prevented or minimised. The high values are indicative of contaminant concentrations where significant adverse



biological effects may be observed. Exceedence of these values could therefore indicate that adverse environmental effects may already be occurring. Contaminant concentrations below the ANZECC (2000) low trigger values therefore, are unlikely to result in the onset of adverse biological effects.

The results presented in Table 5-2 show that the levels of all contaminants measured in the sediments in the vicinity of the Watson Park outfalls in 2010 were generally low. However, closer to the outfall (< 20 m), lead and PAHs were found to be slightly above the ANZECC low trigger value and at distance from the outfalls (> 20 m), arsenic was found to be at the ANZECC low trigger value. Whilst below trigger values, arsenic, chromium, nickel and faecal coliforms were all measured at higher levels at the sample site further away from the outfall.

It is difficult to draw conclusions from this single data set. The harbour in this location currently receives stormwater from residential / commercial land uses and parts of the railway. However, in the past a tannery was located in this area and until the late 1970s effluent from the tannery was discharged into Sawyers Bay, this may have contributed to historic contamination of the sediments in this location (Probert, 1990a).

Sections 6 and 8 of this report discuss stormwater quality and assess the effects on the environment in further detail.

### 5.2 Freshwater Receiving Environment

The Port Chalmers catchment does not contain any open channels or watercourses; the stormwater network is piped and discharges to the marine environment.



Table 5-2: Marine Sediment Guideline Values and Measured Contaminant Levels

| Contaminant       | ANZECC Trigger Value <sup>1</sup> |      | Watson Park Outfalls |        | Comment                                              |
|-------------------|-----------------------------------|------|----------------------|--------|------------------------------------------------------|
|                   |                                   |      | < 20 m               | > 20 m |                                                      |
|                   | Low                               | High | 2010                 | 2010   |                                                      |
| Arsenic (As)      | 20                                | 70   | 4.9                  | 20.0   | Both samples at or below ANZECC low trigger value    |
| Cadmium (Cd)      | 1.5                               | 10   | 0.490                | 0.135  | Both samples at or below ANZECC low trigger value    |
| Chromium (Cr)     | 80                                | 370  | 19.1                 | 67.0   | Both samples at or below ANZECC low trigger value    |
| Copper (Cu)       | 65                                | 270  | 53.0                 | 18.3   | Both samples at or below ANZECC low trigger value    |
| Nickel (Ni)       | 21                                | 52   | 9.2                  | 20.0   | Both samples at or below ANZECC low trigger value    |
| Lead (Pb)         | 50                                | 220  | 51                   | 28     | Near outfall sample exceeds ANZECC low trigger value |
| Zinc (Zn)         | 200                               | 410  | 171                  | 127    | Both samples at or below ANZECC low trigger value    |
| PAHs              | 4                                 | 45   | 17.14                | 2.40   | Near outfall sample exceeds ANZECC low trigger value |
| Enterococci*      | -                                 | -    | 54                   | 24     | Low concentrations                                   |
| Faecal coliforms* | -                                 | -    | 21                   | 170    | Low concentrations.                                  |

1. All values in units of mg/kg dry weight, except those contaminants marked with an \*, which are in MPN/g.

NB. Contaminant concentrations below low trigger values are unlikely to result in the onset of adverse biological effects and therefore are not considered significant.

#### KEY:



Exceeds Low ANZECC Trigger Value

Exceeds High ANZECC Trigger Value



## **6 Stormwater Quality**

This section of the report provides a description of stormwater quality monitoring undertaken to date in and around the catchment, and provides a characterisation of the stormwater quality being discharged from the Port Chalmers catchment based on the information available.

### **6.1 Stormwater Quality Monitoring**

Annual water quality sampling of the stormwater discharges in this catchment is required as a condition of the discharge consents. Two outfalls from the Port Chalmers catchment have been included in this sampling regime, the George Street outfall and the larger Watson Park outfall.

The resource consents for stormwater discharge from this catchment require that the water quality sampling shall be undertaken; following one storm event annually, during storms with an intensity of at least 2.5 mm of rainfall in a 24 hour period and the storms must be preceded by at least 72 hours of no measureable rainfall.

Monitoring of the stormwater quality at the outfall has been carried out by Ryder Consulting Ltd. Several rounds of monitoring have been completed to date; 2007, 2008, 2009 and 2010. A grab sample was taken from the stormwater outfall within one hour of the commencement of a rainfall event to attempt to ensure that the first flush, and therefore worst case scenario, is captured.

Three time-proportional stormwater quality samples have also been taken across Dunedin as part of the 3 Waters Strategy; one at South Dunedin (2009), one at Bauchop Street (2009), and one at Port Chalmers (2010). These three sites provide stormwater quality representing industrial / residential, commercial / residential, and residential land uses respectively. The Port Chalmers time-proportional sampling was carried out near the larger Watson Park outfall and therefore gives further information regarding the range of stormwater contaminants discharged from this catchment during a rainfall event.

### **6.2 Stormwater Quality Results**

Urban stormwater can contain a wide range of contaminants, ranging from suspended sediments and micro-organisms to metals and petroleum compounds, amongst others. The sources of the contaminants are also wide ranging in urban environments with anthropogenic activities significantly contributing to runoff quality.

Table 6-1 presents the results of the annual monitoring at the Port Chalmers catchment outfalls, which is undertaken via a grab-sampling technique, providing a 'snapshot' of stormwater quality during a storm event.

Table 6-2 shows the results of the time proportional sampling in Dunedin. The results provide an indication of the variations in contaminant concentrations throughout the duration of a rainfall event for catchments with differing urban land uses. The results from the Port Chalmers catchment are highlighted in this table.

There are no specific guidelines for stormwater discharge quality, either nationally or internationally, however Table 6-3 presents stormwater quality data from a variety of sources. This information provides an indication of 'typical' stormwater contaminant concentrations that might be expected from urban catchments.



Considerable variability can be expected in stormwater sampling due to antecedent conditions (the number of dry days prior to rainfall) and event characteristics (intensity and duration of rainfall) affecting the amount of sediment (and hence contaminants) present in the stormwater. Additionally, the grab-sampling technique employed may have taken a sample at any point during the event.

The annual monitoring results indicate that the level of contaminants in the stormwater is variable between the years monitored, however some contaminants have been below detectable levels in a number of the monitoring years, in particular in stormwater from the Watson Park outfall.

In general the levels of all contaminants measured in the stormwater samples from this catchment are relatively low and within or below the range typically observed from this type of catchment when compared with stormwater data from the variety of sources listed in Table 6-3.

The exception to this is in 2007 when faecal coliforms were measured above the typical range for urban stormwater (1,000 – 21,000 MPN/100 ml) (Metcalf & Eddy, 1991) from the Watson Park outfall. The FWA concentration, measured in the Watson Park outfall stormwater in 2007 was at the lowest measured levels across the four monitoring years. In addition there were no recorded wastewater flooding complaints for this catchment during this year. This would suggest that the elevated faecal coliform levels measured in 2007 are not likely to be related to wastewater inputs and also appear to be an isolated incident.

The presence of FWAs within the stormwater can be an indication of human waste contamination within the stormwater. It is expected therefore that where human wastewater is present in the stormwater, elevated levels of microbial contamination will correspond with elevated levels of FWAs.

The time proportional monitoring in the Port Chalmers catchment (2010) indicates the range of contaminants in the stormwater throughout a rainfall event. The results correspond with the annual monitoring results with all contaminants levels relatively low and many found to be below detectable limits.



Table 6-1: Stormwater Quality Consent Monitoring Results – Port Chalmers Catchment Outfalls

| Year                  | Contaminant |                  |         |        |        |        |        |       |     |                |       |           |                  |
|-----------------------|-------------|------------------|---------|--------|--------|--------|--------|-------|-----|----------------|-------|-----------|------------------|
|                       | pH          | As               | Cd      | Cr     | Cu     | Ni     | Pb     | Zn    | TSS | Oil and Grease | FWA   | E.Coli    | Faecal Coliforms |
|                       |             | g/m <sup>3</sup> |         |        |        |        |        |       |     |                | µg/l  | MPN/100ml | cfu/100ml        |
| George Street Outfall |             |                  |         |        |        |        |        |       |     |                |       |           |                  |
| 2007                  | 6.9         | BDL              | 0.00028 | 0.0050 | 0.0213 | 0.0029 | 0.0342 | 0.288 | 87  | 10.0           | BDL   | 1400      | 1400             |
| 2008                  | 7.1         | 0.0031           | 0.00140 | 0.0120 | 0.0390 | 0.0093 | 0.0410 | 0.660 | 150 | 8.7            | BDL   | 930       | 1400             |
| 2009                  | 7.3         | BDL              | 0.00011 | 0.0031 | 0.0250 | 0.0026 | 0.0180 | 0.190 | 26  | BDL            | 0.030 | 1000      | 1000             |
| 2010                  | 6.8         | BDL              | 0.00033 | 0.0014 | 0.0148 | 0.0060 | 0.0048 | 0.420 | 170 | BDL            | 0.079 | 1100      | 1100             |
| Watson Park Outfall   |             |                  |         |        |        |        |        |       |     |                |       |           |                  |
| 2007                  | 6.8         | BDL              | BDL     | BDL    | 0.0090 | BDL    | 0.0141 | 0.231 | 37  | 8.0            | 0.002 | 14000     | 39000            |
| 2008                  | 7.9         | BDL              | BDL     | 0.0064 | 0.0025 | BDL    | 0.0018 | 0.027 | 39  | BDL            | 0.003 | 150       | 150              |
| 2009                  | 8.2         | BDL              | BDL     | BDL    | BDL    | BDL    | BDL    | BDL   | 7.4 | BDL            | 0.124 | 10        | 10               |
| 2010                  | 7.1         | BDL              | BDL     | BDL    | BDL    | 0.0035 | BDL    | 0.290 | 240 | BDL            | 0.105 | > 1600    | > 1600           |

BDL = Below detection limits



Table 6-2: Dunedin Time Proportional Stormwater Monitoring Results, Contaminant Ranges

| Location, Date<br>(Land Use)                       | Contaminant |                    |                  |                    |                  |                    |                    |                  |             |                |                 |                  |
|----------------------------------------------------|-------------|--------------------|------------------|--------------------|------------------|--------------------|--------------------|------------------|-------------|----------------|-----------------|------------------|
|                                                    | pH          | As                 | Cd               | Cr                 | Cu               | Ni                 | Pb                 | Zn               | TSS         | Oil and Grease | E.Coli          | Faecal Coliforms |
|                                                    |             | g/m <sup>3</sup>   |                  |                    |                  |                    |                    |                  |             |                | MPN/<br>100ml   | cfu/<br>100ml    |
| South Dunedin, 2009<br>(Industrial / Residential)  | 7.0 - 7.7   | 0.0012 -<br>0.0052 | BDL -<br>0.00041 | 0.0011 -<br>0.0074 | BDL -<br>0.064   | 0.0067 -<br>0.0730 | 0.0008 -<br>0.0044 | 0.230 -<br>0.840 | 17 -<br>160 | 26 - 42        | 3900 -<br>14000 | 5400 -<br>20000  |
| Bauchop Street, 2009<br>(Commercial / Residential) | 6.7 - 7.9   | BDL -<br>0.0038    | BDL -<br>0.00054 | BDL -<br>0.0500    | 0.040 -<br>0.230 | BDL -<br>0.0870    | BDL -<br>0.0870    | 0.05 -<br>2.50   | 26 -<br>330 | 7 - 53         | n/a             | n/a              |
| Port Chalmers, 2010<br>(Residential)               | 7.6 - 7.9   | BDL                | BDL              | BDL                | BDL              | BDL -<br>0.1080    | 0.0024 -<br>0.0077 | 0.108 -<br>0.260 | 8 - 47      | 6 - 18         | n/a             | 320 -<br>1000    |

BDL = below detection limit



**Table 6-3: Comparison of Port Chalmers Catchment Stormwater Quality with Other Stormwater Quality Data**

| Contaminant<br>(g/m <sup>3</sup> ) | Time<br>Proportional<br>Dunedin | Christchurch<br>Recommended<br>Provisional<br>Mean Values <sup>1</sup> | Pacific Steel,<br>Auckland <sup>2</sup> | Brookhaven<br>Subdivision <sup>3</sup> | Australian<br>Stormwater<br>Mean <sup>4</sup> | Urban Highway,<br>USA <sup>5</sup> | New Zealand<br>Data Range <sup>2</sup> | Port Chalmers<br>2010 |
|------------------------------------|---------------------------------|------------------------------------------------------------------------|-----------------------------------------|----------------------------------------|-----------------------------------------------|------------------------------------|----------------------------------------|-----------------------|
|                                    | Residential /<br>Industrial     | Christchurch                                                           | Industrial                              | Residential                            | Australian sites                              | Highway                            | Urban                                  | Residential           |
| TSS                                | 8 - 330                         | 33 - 200                                                               | 124                                     | 5 - 49                                 | 164                                           | 142                                | -                                      | 8 - 240               |
| Zinc                               | 0.05 - 2.50                     | 0.40                                                                   | 2.80                                    | 0.003 - 0.260                          | 0.910                                         | 0.329                              | 0.09 - 0.80                            | 0.108 - 0.290         |
| Copper                             | BDL - 0.23                      | 0.05                                                                   | 0.08                                    | 0.002 - 0.031                          | 0.08                                          | 0.054                              | 0.015 - 0.110                          | BDL                   |
| Lead                               | BDL - 0.087                     | 0.075                                                                  | 0.23                                    | 0.003 - 0.007                          | 0.25                                          | 0.4                                | 0.06 - 0.19                            | BDL - 0.0077          |

BDL = below detection limit

<sup>1</sup> Christchurch City Council (2003). <sup>2</sup> Williamson (1993). <sup>3</sup> Zollhoefer (2008). <sup>4</sup> Wendelborn et al. (2005). <sup>5</sup> U.S. Department of Transportation Federal Highway Administration (1990).



## 7 Stormwater Quantity

### 7.1 Introduction

A linked 1 and 2-dimensional hydrological and hydraulic model of the Port Chalmers catchment and stormwater network was developed to replicate the stormwater system performance, and to predict flood extents during a number of different scenarios. Two modelling reports were produced for DCC; the '*Port Chalmers Model Build Report*' (Opus, 2011a), and the '*Port Chalmers Catchment Hydraulic Performance Report*' (Opus, 2011b), and the information presented in this section is sourced from these reports. Figure 7-1 provides a diagram of the model extent.

The modelling analysed a number of influences on the system, as follows:

- Two alternative catchment imperviousness figures; one for the current land use, and one for the future, representing the likely maximum imperviousness.
- Seven different high tide situations; current MHWS; MHWS with 2030 and 2060 medium and extreme climate change scenarios; and MHWS with two storm surges (1 in 2 yr ARI applied to current, and 1 in 20 yr ARI applied to 2060 extreme climate change).
- Five design rainfall events; 1 in 2 yr, 1 in 5 yr, 1 in 10 yr, 1 in 50 yr and 1 in 100 yr ARI events (refer Rainfall Analysis, Appendix D).
- Three climate change scenarios; no climate change, mean climate change, and extreme climate change (for 2031 and 2060 design horizons).

A single flow monitor was installed in the catchment, and due to difficulties finding appropriate monitoring locations, this monitor only measured flows from a sub-catchment upstream of Outfall 2.

The model relied for the most part on DCC GIS and Hansen (database) information regarding network configuration and detail. Site visit information, operational knowledge and LiDAR (light detecting and ranging) survey data were also incorporated into the model. Catchment hydrological (runoff) parameters were estimated based on the calibrated model built for the pilot catchment, South Dunedin, and adjusted during calibration.

Confidence in the model output is considered to be moderate to low, based on partial calibration and correlation with known flooding locations. The model has been built using accepted sound methodology by experienced modellers and engineers. The model output is not absolute, however it is an adequate tool for the purposes of indicating areas with a potential to flood, and allowing the comparative effects of the different rainstorms and climate change to be assessed.

### 7.2 Model Results

Fourteen scenarios representing different land use, rainfall, climate change and tide combinations have been modelled. Tables 7-1 and 7-2 provide the results of the modelling, in relation to information required to assess the performance of the system and enable the environmental effects to be determined.

Section 8 analyses the modelling results in order to identify key issues relating to system capacity and flooding. In general, DCC are particularly concerned with the point at which a manhole is predicted to overflow and cause flooding (particularly to potential habitable floor level); however the pipe surcharge state, and manholes that are 'almost' overflowing, are also of relevance when considering available capacity in the system.



With respect to flooding of private property, model results are presented as a 'number of land parcels with flood depth potentially  $\geq 300$  mm', and are based on a GIS assessment of DCC cadastral maps, overlaid with modelled flood extents. When targets for protection of private property are set (Section 11) these are set to limit the flood risk to private property and habitable floors. As discussed further in Section 8, the modelled deep flooding of part of a parcel does not necessarily mean that the entire property is inundated; further detail (including survey) is generally required to confirm the risk to habitable floors.

**Table 7-1: Port Chalmers Model Results – Current Land Use**

| Hydraulic Performance Measure                                                                         | ARI                    | Current and Use |
|-------------------------------------------------------------------------------------------------------|------------------------|-----------------|
| Percentage of manholes predicted to overflow                                                          | 1 in 2 <sup>1</sup> yr | 5               |
|                                                                                                       | 1 in 5 yr              | 15              |
|                                                                                                       | 1 in 10 yr             | 33              |
| Number of land parcels with flood depth potentially $\geq 300$ mm <sup>2</sup>                        | 1 in 2 <sup>1</sup> yr | 0               |
|                                                                                                       | 1 in 5 yr              | 0               |
|                                                                                                       | 1 in 10 yr             | 4               |
|                                                                                                       | 1 in 50 yr             | 9               |
|                                                                                                       | 1 in 100 yr            | 9               |
| Estimated flood extent<br>(% of catchment area with flood depth $\geq 50$ mm)                         | 1 in 2 <sup>1</sup> yr | 0.04            |
|                                                                                                       | 1 in 5 yr              | 0.16            |
|                                                                                                       | 1 in 10 yr             | 0.68            |
|                                                                                                       | 1 in 50 yr             | 1.85            |
|                                                                                                       | 1 in 100 yr            | 2.57            |
| Modelled percentage (by number) of pipes surcharging                                                  | 1 in 2 <sup>1</sup> yr | 39              |
|                                                                                                       | 1 in 5 yr              | 67              |
|                                                                                                       | 1 in 10 yr             | 80              |
| Percentage of manholes predicted to be close to overflowing (free water level within 300 mm of cover) | 1 in 2 <sup>1</sup> yr | 11              |
|                                                                                                       | 1 in 5 yr              | 22              |
|                                                                                                       | 1 in 10 yr             | 44              |

<sup>1</sup> 1 in 2.33 year event (mean annual flood)

<sup>2</sup> On all or part of a land parcel, or against a building void in the 2-D surface

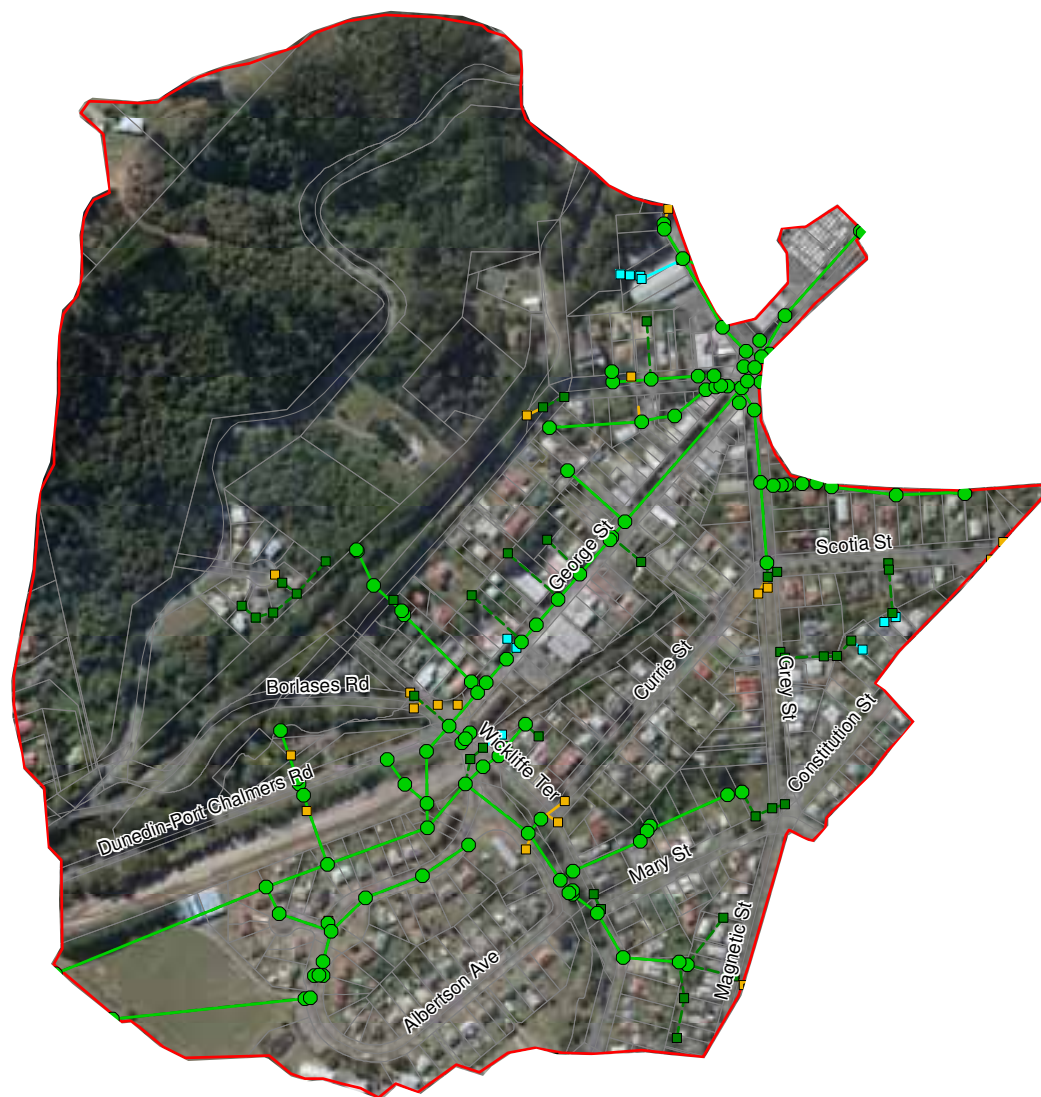


**Table 7-2: Port Chalmers Model Results – Future Land Use / Climate Change**

| Hydraulic Performance Measure                                                            | ARI         | Planning Scenario |                     |                        |                     |                        |
|------------------------------------------------------------------------------------------|-------------|-------------------|---------------------|------------------------|---------------------|------------------------|
|                                                                                          |             | 2031              |                     |                        | 2060                |                        |
|                                                                                          |             | Growth Only       | Mean Climate Change | Extreme Climate Change | Mean Climate Change | Extreme Climate Change |
| Percentage of manholes predicted to overflow                                             | 1 in 10 yr  | 48                | 49                  | 50                     | 52                  | 55                     |
| Number of land parcels with flood depth potentially $\geq 300$ mm <sup>1</sup>           | 1 in 10 yr  | 6                 | 7                   | 8                      | 8                   | 9                      |
|                                                                                          | 1 in 50 yr  |                   | 11                  |                        | 12                  |                        |
|                                                                                          | 1 in 100 yr |                   |                     |                        |                     | 15 <sup>2</sup>        |
| Estimated Flood Extent ( % of catchment area with flood depth $\geq 50$ mm) <sup>2</sup> | 1 in 10 yr  | 1.34              | 1.55                | 1.74                   | 1.82                | 2.35                   |
|                                                                                          | 1 in 50 yr  |                   | 2.95                |                        | 3.32                |                        |
|                                                                                          | 1 in 100 yr |                   |                     |                        |                     | 6.03 <sup>2</sup>      |
| Modelled percentage (by number) of pipes surcharging                                     | 1 in 10 yr  | 88                | 89                  | 90                     | 91                  | 91                     |
| Percentage of manholes with free water level within 300 mm of cover                      | 1 in 10 yr  | 59                | 60                  | 62                     | 62                  | 66                     |

<sup>1</sup> On all or part of a land parcel, or against a building void in the 2-D surface

<sup>2</sup> Includes areas flooded outside the catchment boundary



### Legend

- Port Chalmers Catchment Boundary
- Modelled Manhole
- Pruned Manhole (not modelled)
- Drain Manhole (not modelled)
- Catchpit (not modelled)
- Modelled Pipe
- - - Pruned Pipe (not modelled)
- Drain Pipe (not modelled)
- Catchpit Pipe (not modelled)
- Roads



## Dunedin 3 Waters Strategy

### PORT CHALMERS INTEGRATED CATCHMENT MANAGEMENT PLAN

Figure 7-1  
Model Extent

Discipline:  
Stormwater

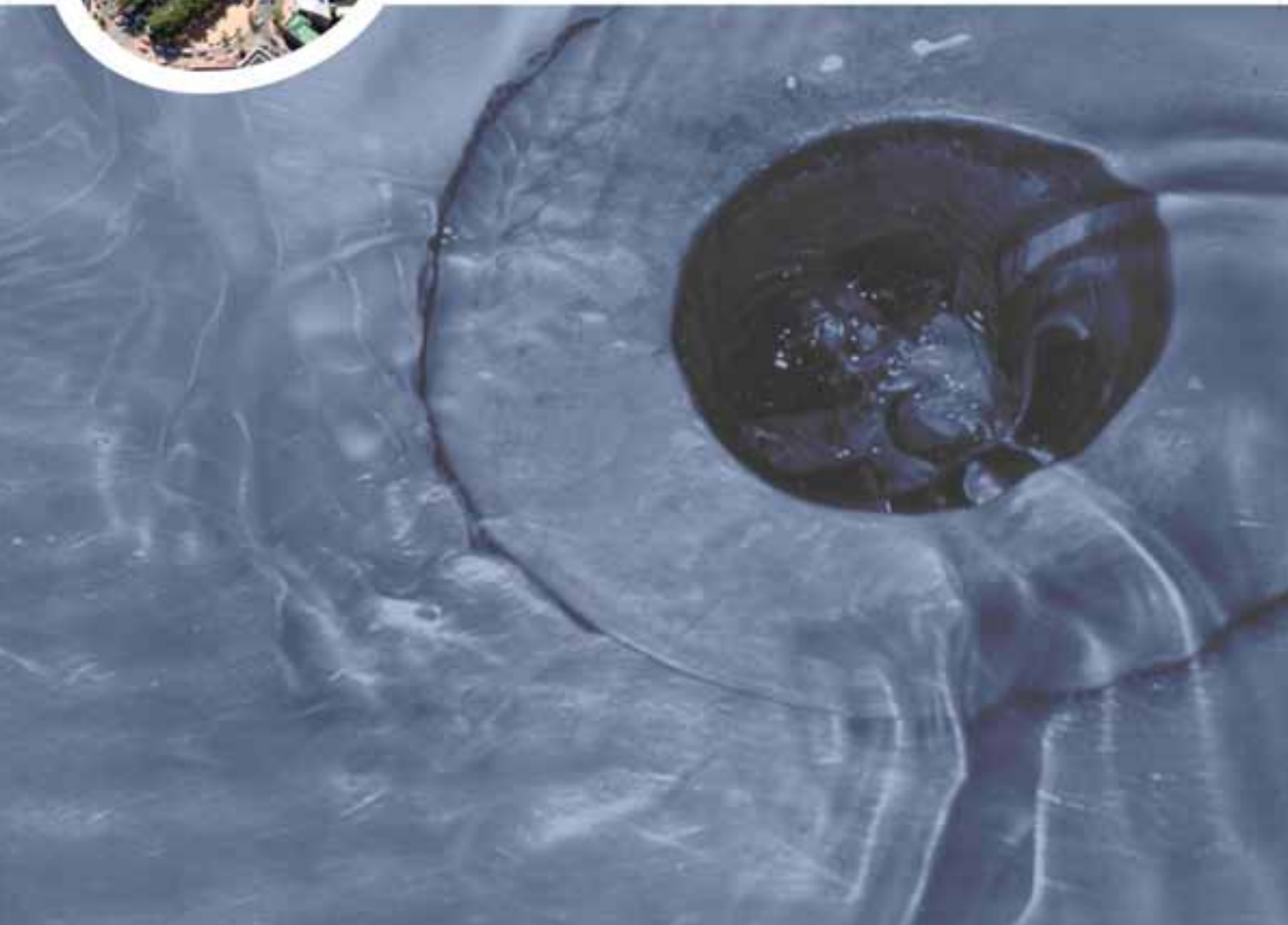
| DESIGN     |          | Final      |          |
|------------|----------|------------|----------|
| DATE       | MH       | DATE       | Final    |
| 2020/03/05 | MG       | DATE       | April 11 |
| 2020/03/05 | WB       | DATE       |          |
| 2020       | April 11 | 3-d1040.07 |          |





## Part 3

### Analysis







## 8 Assessment of Environmental Effects

This section identifies and summarises the actual and potential environmental effects on the stormwater network and natural environment relating to stormwater quantity and quality within the catchment.

The effects are summarised based on the interpretation of the outcomes of the stormwater network hydraulic modelling and the associated flood maps; the marine and stream assessments; information gathered during catchment walkovers; DCC flood complaint records; and workshops with DCC Network Management and Maintenance staff.

### 8.1 Stormwater Quantity

#### 8.1.1 Benefits of the Stormwater Network

Urban development significantly increases the area of impervious surfaces from which rainfall quickly runs off. These surfaces include building roofs, paved areas, roads and carparks, and they can also include, but to a lesser extent, grassed and garden areas. In Dunedin, the stormwater network controls the urban runoff, collecting the flows within the system and directing it to the receiving environment. The stormwater network therefore provides a number of benefits to the community.

DCC is responsible for managing the stormwater system in order to provide the best system possible at a reasonable cost to the ratepayer. The objectives set for stormwater management by DCC are outlined in the Stormwater AMP, as follows:

*“The key objective of the Stormwater Activity is to protect public health and safety by providing clean, safe and reliable stormwater services to every customer connected to the network with minimal impact on the environment and at an acceptable financial cost. In addition to ensuring effective delivery of today’s service, we also need to be planning to meet future service requirements and securing our ability to deliver appropriate services to future generations.”*

The stormwater activity is particularly focused on providing protection from flooding and erosion, and controlling and reducing the levels of pollution and silt in stormwater discharge to waterways and the sea, and the overall objective is broken down into the individual activity objectives of:

- Ensuring stormwater discharges meet quality standards;
- Ensuring services are available;
- Managing demand;
- Complying with environmental consents;
- Strategic investment;
- Maintaining assets to ensure serviceability; and
- Managing costs.



### 8.1.2 Stormwater Quantity Effects

The hydraulic model results, summarised in Table 7-1 and 7-2, have been used to assess the hydraulic performance of the stormwater network with respect to the criteria shown in the tables. This information has been analysed alongside flood maps, observed catchment issues, anecdotal evidence and operational information, to assess the effects of stormwater quantity within the Port Chalmers catchment.

Each planning scenario modelled used a range of assumptions which are outlined in Section 7. Flow monitoring was undertaken in part of the Port Chalmers catchment and the model calibrated to replicate observed flow, depth and velocity data as well as possible. A historical rainfall event (February 2005) was also simulated, and model results compared with reported flooding information for the same event in order to validate the model. As the historical records of flooding matched reasonably well with the model's predicted flooding, and the historical event is considered to be greater than a 1 in 10 yr ARI, confidence in the model is considered to be moderate for the calibrated section and low for other areas.

It should be noted that with a low to moderate level of confidence, there are some uncertainties in the model. Assumptions regarding the hydrology in the steep undeveloped areas of the catchment represent the highest area of uncertainty. There is additional uncertainty relating to individual pipe diameters and grades due to interpolation of missing GIS data. However, additional manhole inspections provided depth and diameter data for some key locations in the model to improve model confidence in this area.

The effects of stormwater quantity on the network within the Port Chalmers catchment are discussed in the following sections. The benefits of the network and the effects on the level of service, flooding and key system structures are identified in relation to current and future land use scenarios and projected climate change.

### 8.1.3 Infrastructure Capacity

The network analysis and flood mapping undertaken for the current land use show that the predicted level of service provided by the stormwater network in the Port Chalmers catchment is variable (refer Table 7-1, 7-2). Overall, it is predicted to be approximately between a 1 in 5 yr and a 1 in 10 yr ARI rainfall event in most of the catchment, with some areas of exception having a lower level of service. These are discussed below.

In general, DCC are particularly concerned with the point at which a manhole is predicted to overflow and cause flooding (particularly to potential habitable floors); however the pipe surcharge state and manholes that are 'almost' overflowing are also of relevance when considering available capacity in the system.

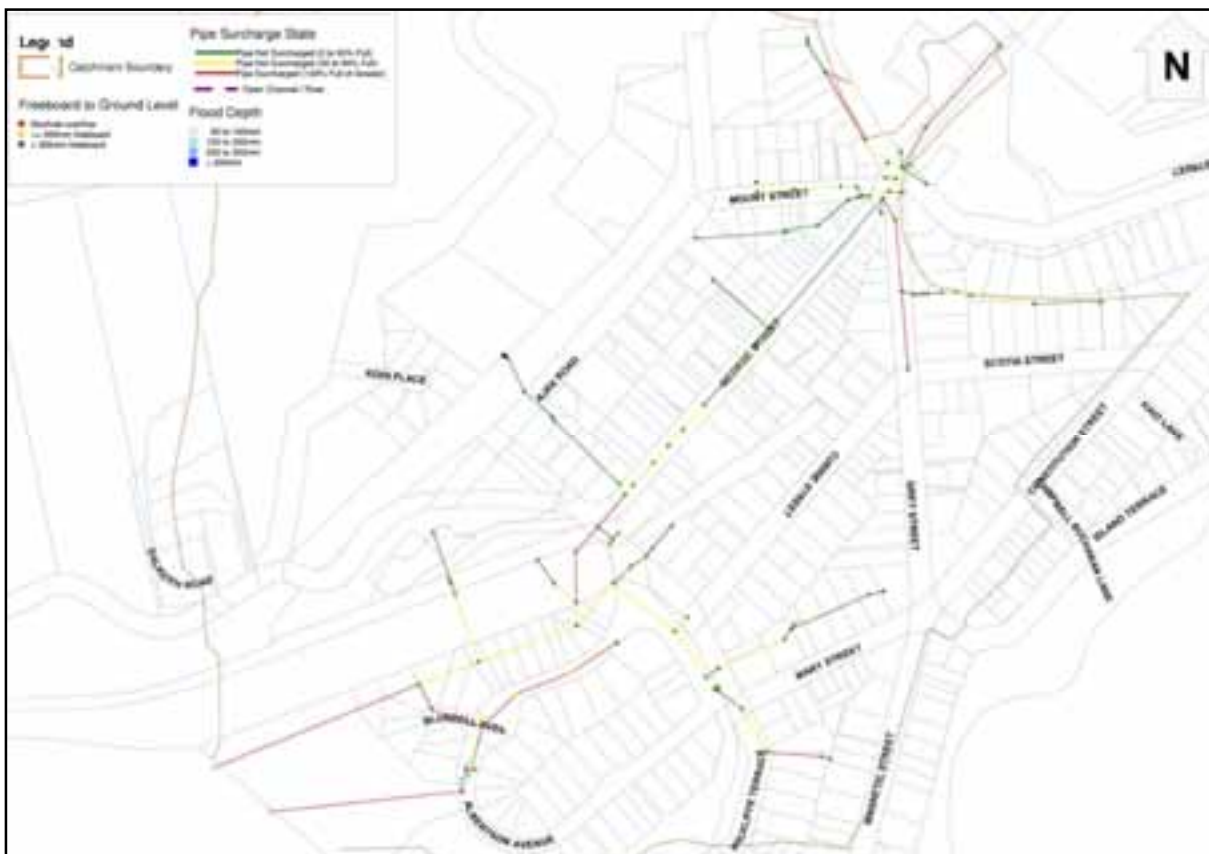
Based on the results presented in Section 7 (manholes overflowing), the model of the stormwater network estimates that the percentage of the network able to accept stormwater flows is as follows:

- 95 % of the network can accept a 1 in 2 yr ARI rainfall event;
- 67 % of the network can accept a 1 in 10 yr ARI rainfall event; and
- 48 % of the network can accept a 1 in 100 yr ARI rainfall event.



It should be noted however, that whilst the stormwater system is able to accept the flows, they may not immediately be conveyed by the network. For example, during a current 1 in 2 yr ARI rainfall event combined with a MHWS tide, some surcharging across the modelled network is predicted, with approximately 39 % of the pipes having no spare capacity and approximately 5 % of all manholes in the catchment predicted to overflow.

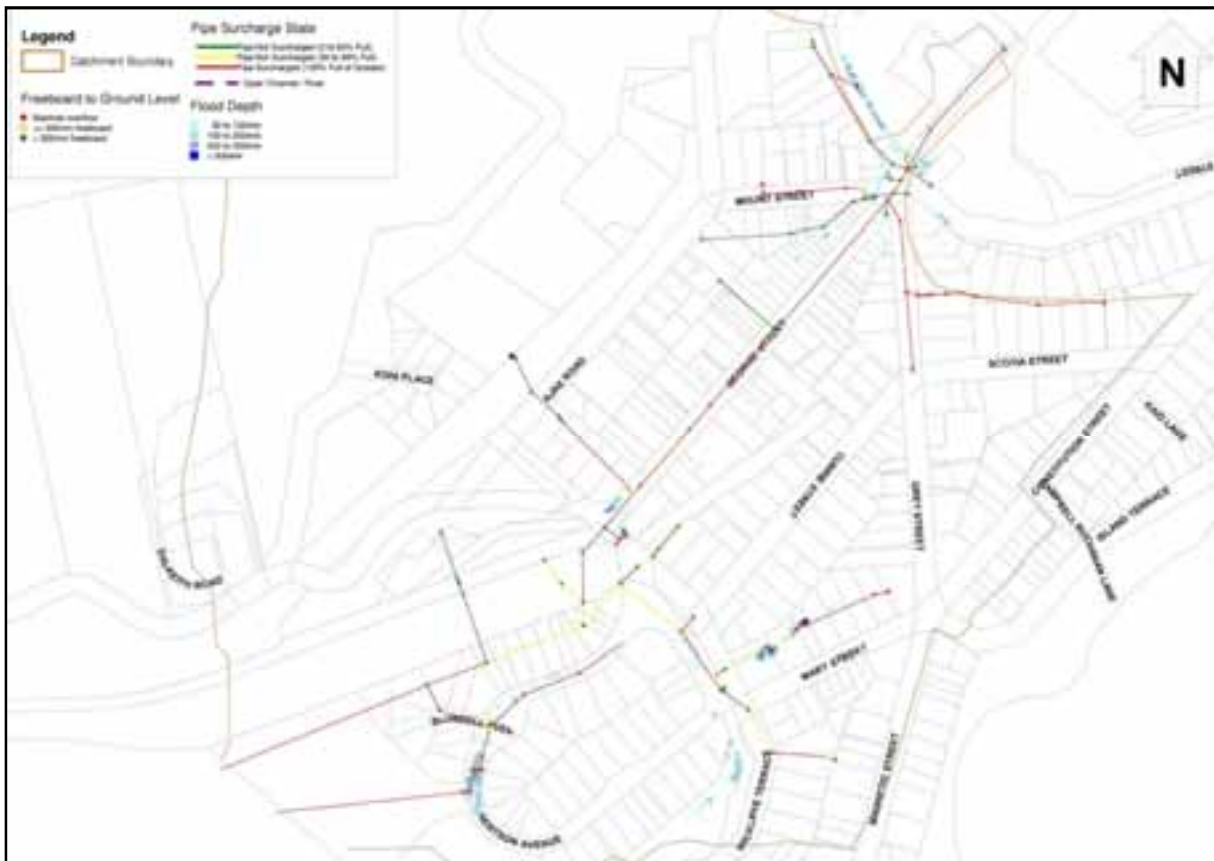
There are some system restrictions during a 1 in 2 yr ARI rainfall event; the majority of which are to the west of the catchment in Albertson Avenue. The pipes in this location are predicted to be flowing full and manhole overflows are predicted. This is shown in Figure 8-1. Current modelling indicates that pipe surcharging and manhole overflows are a result of insufficient network capacity.



**Figure 8-1: 2010 1 in 2 yr ARI Rainfall Event (Model Results)**

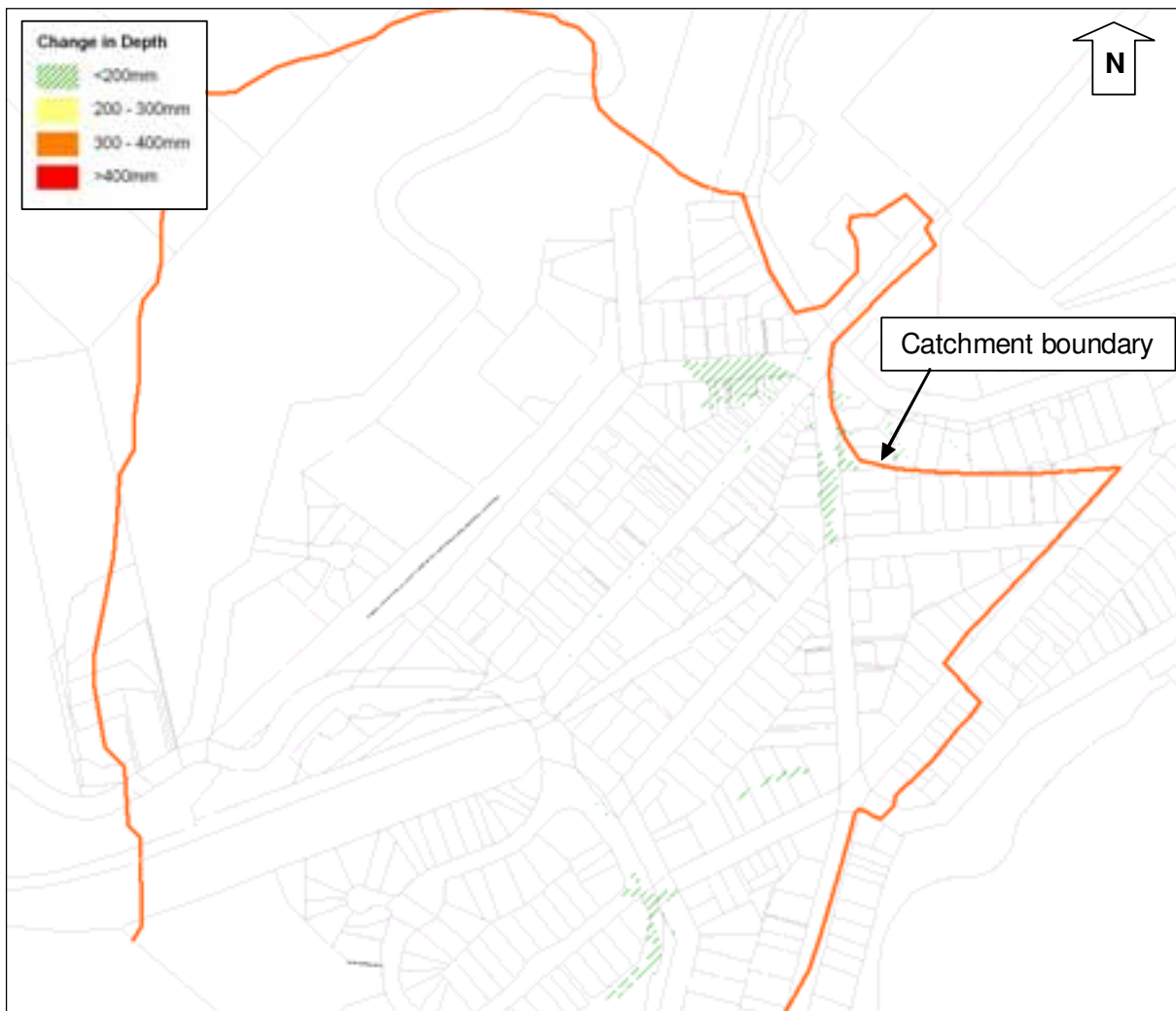
Further to overflows during the 1 in 2 yr ARI event, the number of manhole overflows in the catchment during a 1 in 5 yr ARI rainfall event is estimated to be 16 (an increase from 5 in the 1 in 2 yr ARI event). However, the predicted increase in flood extent and depth during this event is minor.

During a 1 in 10 yr ARI rainfall event, with a MHWS tide, pipe surcharging is predicted throughout the catchment, and the number of manhole overflows is predicted to increase to 36. This comprises 33 % of the manholes in the catchment. Approximately 80 % of the modelled network is also predicted to be flowing full. This is shown in Figure 8-2. The pipe surcharging predicted in the Port Chalmers catchment is as a result of insufficient network capacity in certain locations. Flooding resulting from manhole overflows is discussed in the following sections, along with the anecdotal evidence provided by the DCC Network Management and Maintenance staff.



**Figure 8-2: 2010 1 in 10 yr ARI Rainfall Event (Model Results)**

The three outfalls discharge below the high tide water level. Assessment of the impact of the tidal influence on flood extents and depths in the catchment during a 1 in 10 yr ARI rainfall event revealed that the network capacity in the Port Chalmers catchment is not significantly influenced by the tide in that the predicted surcharging of the network occurs irrespective of the tidal boundary conditions applied to the model. However, the tidal influence on the network is predicted to worsen flooding in certain locations. These are shown in Figure 8-3.



**Figure 8-3: Change in Flood Depth due to Tidal Influence**

### 8.1.4 Flooding

The hydraulic model has been used to indicate areas within the catchment potentially at risk of flooding during a variety of planning scenarios. This includes a range of storm events, current and future land use scenarios and climate change projections, generally modelled with a MHWS tide condition (adjusted for climate change where necessary). These predictions have been validated, where possible, with anecdotal evidence from DCC Network Management and Maintenance staff, and observations made on the catchment walkovers. As outlined in Section 4.8, a number of flood complaints have been made by the public in the catchment in recent years.

Predicted nuisance flooding, habitable floor flooding and flood hazard ratings within the catchment have been assessed, and are discussed in the following sections.

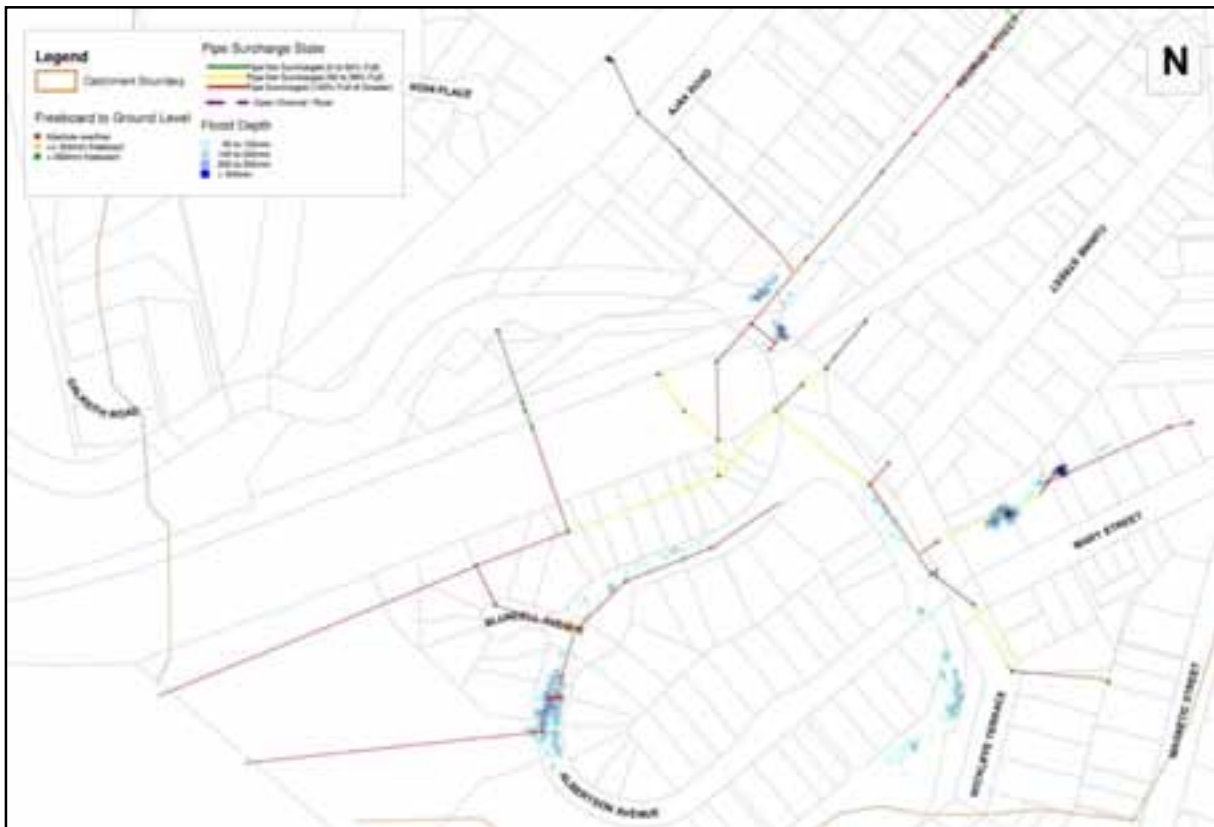
#### 8.1.4.1 Nuisance Flooding

Nuisance flooding constitutes predicted flood depths generally between 50 mm and 300 mm, or flooding in locations unlikely to cause habitable floor flooding or serious transport disruption. Flood depths greater than 300 mm deep pose a potential habitable floor flooding risk, and are discussed in the following section.



Nuisance flooding is predicted to occur in various locations throughout the Port Chalmers catchment, the effects and significance of this flooding is described below.

Table 8-1 presents the key locations affected by nuisance flooding in the catchment during events up to 1 in 10 yr ARI rainfall event; the identification of these locations is based on model outputs combined with confirmation from customer complaints and / or DCC Network Management and Maintenance staff. Figures 8-4 and 8-5 show the significant nuisance flood extents and surcharging manholes contributing to flooding within the catchment.

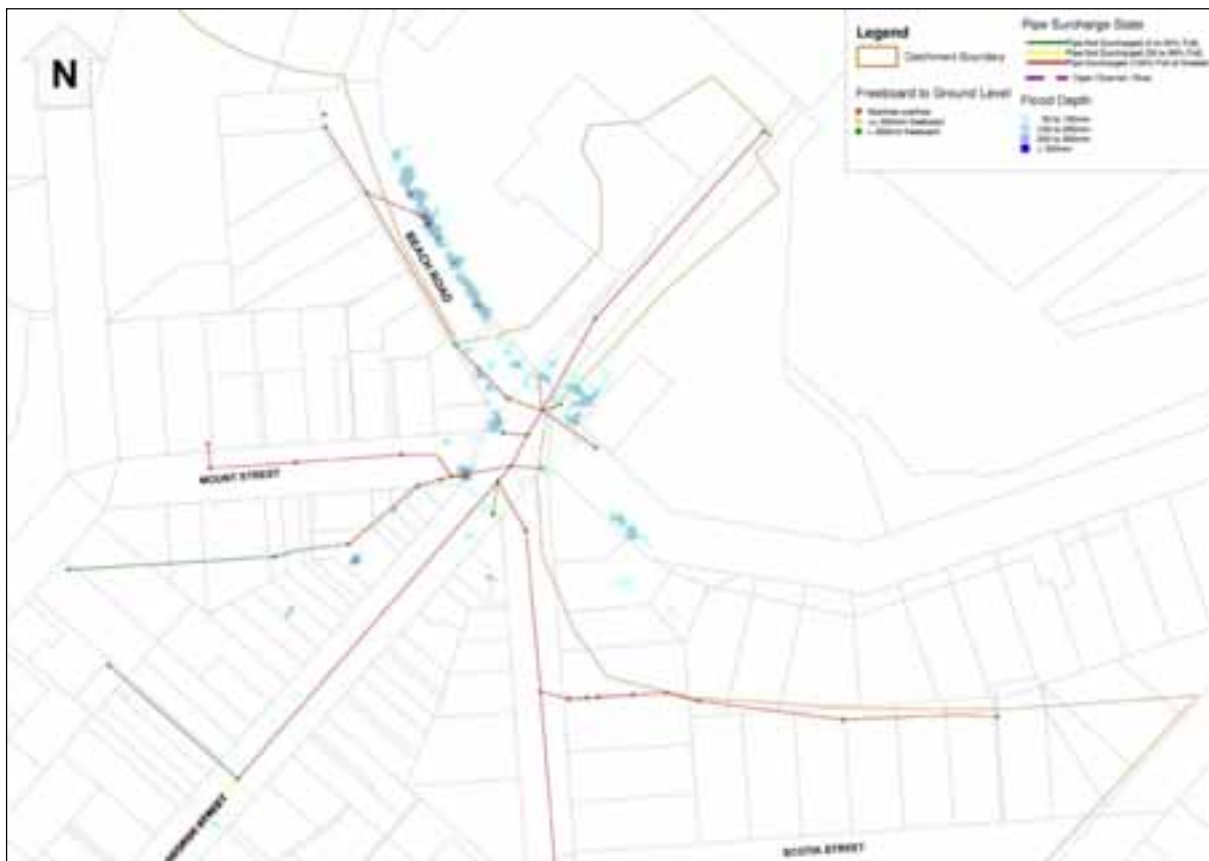


**Figure 8-4: 2010 1 in 10 yr ARI Rainfall Event (Model Results) Albertson Avenue, Wickliffe Terrace, George Street**



**Table 8-1:** Predicted Nuisance Flooding (50 mm - 300 mm) up to a 1 in 10 yr ARI Rainfall Event

| Location                                    | Description                                                                                                                                                                                                                                                                                                                 | Predicted Cause                                                                                                                                                                                                                                       | Minimum Rainfall Event (ARI yr) |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| Albertson Avenue (west)                     | Surcharged pipes and manhole overflows resulting in ponding in the kerb along sections of Albertson Avenue and flooding across the full width of the road to west. Ponding < 300 mm deep in vicinity of kindergarten.                                                                                                       | Downstream hydraulic restriction on Blundel Avenue caused by limited pipe capacity. Flows pond in low point of road.                                                                                                                                  | 1 in 2                          |
| Albertson Avenue (east) / Wickliffe Terrace | Manhole overflows on Albertson Avenue result in shallow ponding in kerb of road.<br>Manhole overflows on Wickliffe Terrace resulting in overland flows down steep bank adjacent to Albertson Avenue. Contributes to shallow ponding in kerb on Albertson Avenue and grass reserve.                                          | Hydraulic restriction caused by reduction in pipe size on Albertson Avenue, manhole overflows at point of restriction.<br>Manhole overflows on Wickliffe Terrace due to undersized pipes.                                                             | 1 in 5                          |
| George Street / Wickliffe Terrace           | Manhole overflows in central portion of George Street (State Highway 88) result in moderate velocity (0.5 – 1.0 m/s), shallow (< 100 mm), overland flows which pond at the intersection with Wickliffe Terrace. Manhole overflows at Wickliffe Terrace intersection contribute to this ponding.                             | Manhole overflows on George Street and Wickliffe Terrace intersection occur due to the limited capacity of the pipes to convey flows.<br>Ponding problems are compounded if catchpits at the intersection are blocked / partially blocked (verified). | 1 in 5                          |
| George Street / Beach Street                | Manhole overflows on George Street, Mount Street and Grey Street result in moderate velocity (0.5 – 1.0 m/s), shallow (< 100 mm), overland flows.<br>Flows pond at the intersection on George Street and also continue to the low point on Beach Street where manhole overflows in this location contribute to the ponding. | Insufficient network capacity results in pipe surcharging and manhole overflows. Flooding is exacerbated by tidal influence on stormwater system, notably in Mount Street and Grey Street.                                                            | 1 in 10                         |



**Figure 8-5: 2010 1 in 10 yr ARI Rainfall Event (Model Results) George Street, Beach Street**

The confirmed nuisance flooding in this catchment predominantly occurs within the kerb of the road in a variety of locations, with one instance of ponding extending the full width of the road.

Stormwater flood complaints recorded between 2005 and 2010 correspond with the locations predicted by the model to experience nuisance flooding. However, the complaints do not show any particular pattern to highlight areas of concern and the exact nature of the problems are usually unspecified.

Workshop discussions revealed that DCC Network Management and Maintenance staff have not experienced any significant problems due to flooding in the Port Chalmers catchment.

In summary, the effects of the confirmed nuisance flooding are unlikely to cause significant traffic disruptions, risk to pedestrian traffic or threats to property interiors and are therefore considered to be minor.

Further to the areas indicated in Table 8-1, the model predicts another area may experience nuisance flooding in small events (and consequently more severe flooding in larger events), as described in Table 8-2 below. This flooding is unconfirmed by customer complaints or anecdotal evidence.



**Table 8-2: Modelled Flood Areas (Unconfirmed)**

| Location    | Description                                                                                                                                                                                                                                                                                                                                                             | Predicted Cause                                                                                                                           | Minimum Rainfall Event (ARI yr) |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| Mary Street | Model indicates areas of deep flooding (> 300 mm) within residential property boundary, however away from the building.<br>Network Management and Maintenance staff indicated that there may have been an issue in this location in the past on the property adjacent to that predicted to flood. Issue now understood to be resolved due to private works on property. | Low confidence in the model at this location. Site visits and anecdotal evidence confirm that flooding is unlikely to occur as predicted. | 1 in 5                          |

It should be noted that the nuisance flooding and effects described are predicted to worsen when future planning scenarios are applied to the model. Figure 8-6 indicates the predicted network surcharging and flooding during a future (2060) 1 in 10 yr ARI rainfall event. The predicted effects are summarised as follows:

- 91 % of pipes are predicted to be surcharging and 55 % of manholes are predicted to overflow.
- Flood extents increase covering the full width of the road in on Albertson Avenue (east and west), Wickliffe Terrace (intersection) and George Street (port entrance).
- Flood depths are predicted to exceed 300 mm in certain locations; this is predominantly within the road and unlikely to threaten building interiors. However, it may cause some traffic disruptions / bottlenecks, notably on George Street (State Highway 88).

As future land use changes in the catchment are unlikely to be significant the future increase in flooding predicted is almost entirely as a result of projected climate change effects.

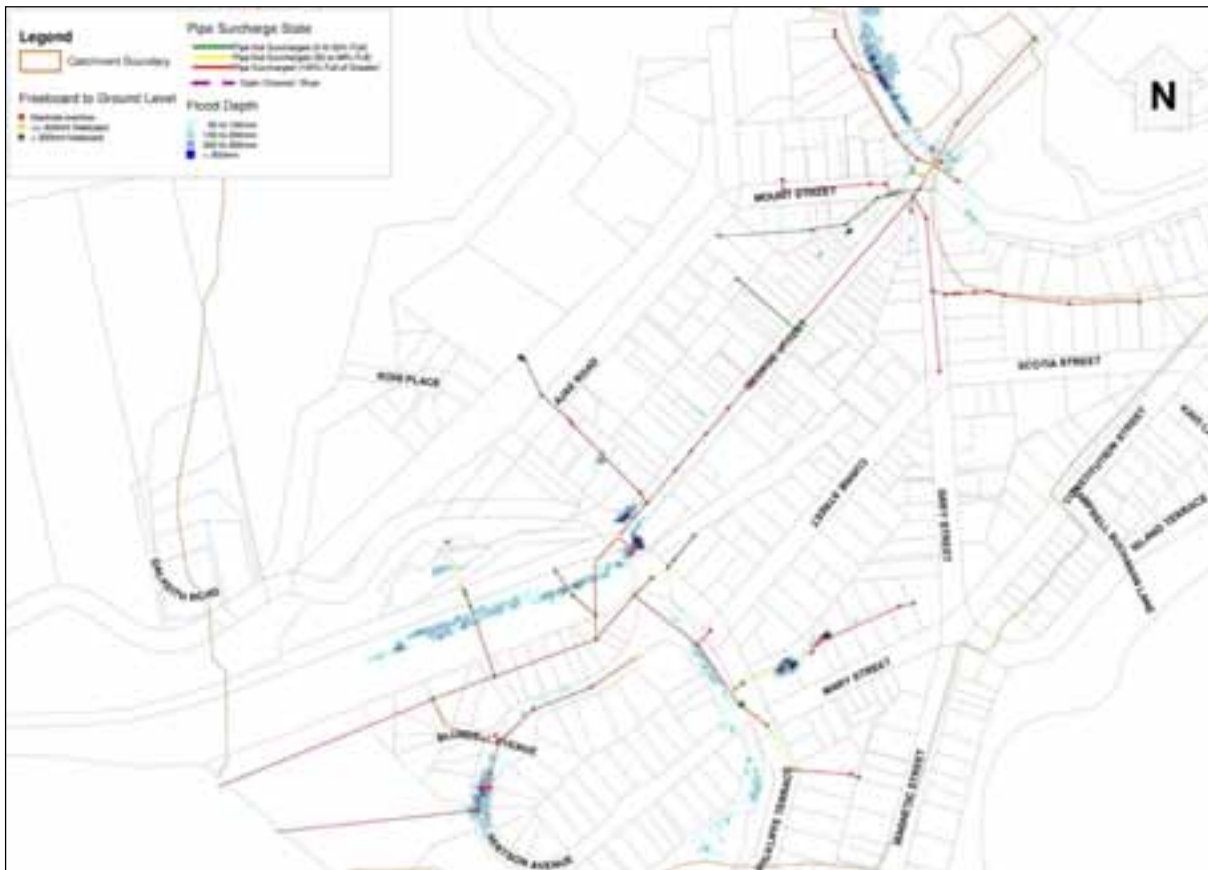


Figure 8-6: 2060 1 in 10 yr ARI Rainfall Event (Model Results)

#### 8.1.4.2 Habitable Floor Flooding

Predicted flood depths equal to or greater than 300 mm present a risk of habitable floor flooding. Habitable floor flooding is the flooding of 'useful floor space' for any zoning (including industrial). This is defined as the floor space of a dwelling or premises inside the outer wall, excluding cellars and non-habitable basements. Land parcels (properties) have been defined as 'at risk' of habitable floor flooding where the property boundary is intersected by a flood plain depth of equal to or greater than 300 mm. It should be noted however, that the exact location of buildings and corresponding floor levels are not documented so it is not usually known whether flooding may only occur within the property boundary or affect the building.

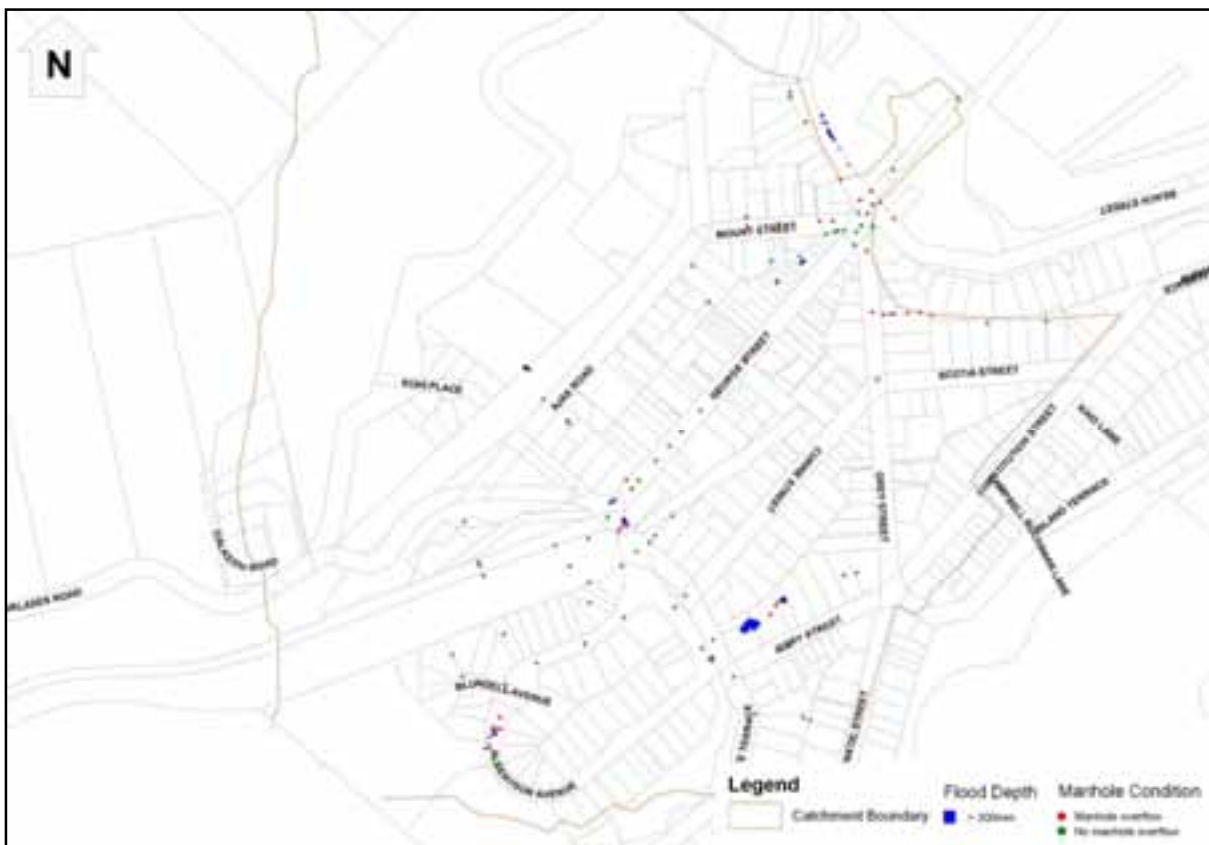
New stormwater systems are designed to avoid habitable floor flooding during a 1 in 50 yr ARI rainfall event. For existing systems, analysis of a variety of rainfall events is undertaken in order to assess the risk of flooding.

It should be noted that although the model predicts that a number of land parcels will experience deep flooding (> 300 mm), particularly during a 1 in 50 yr ARI rainfall event, some occur in locations where the predicted flooding is unconfirmed and confidence in the model is low and therefore the actual degree of flood risk is less certain. Information gathered from catchment walkovers, data analysis and engineering judgement has been applied in these situations, as well as model analysis. The risks of deep flooding are described below.



During a current 1 in 50 yr ARI rainfall event approximately nine land parcels are predicted to experience flood depths of greater than 300 mm, an increase of five from the 1 in 10 yr ARI event. This is shown in Figure 8-7. It is uncertain however, whether this flooding is likely to enter habitable floors as no floor levels surveys have been undertaken. Furthermore, the majority of properties are only predicted to experience flooding on part of the land parcel and away from buildings.

Whilst workshop discussions have verified the locations of some the predicted flooding, flood depths have not been confirmed and there are no known incidents of habitable floors being flooded in this catchment. Furthermore, no flood complaint records exist in the catchment indicating habitable floor flooding.



**Figure 8-7: 2010 1 in 50 yr ARI Rainfall Event (Model Results)**

Future land use with the application of 2060 mean climate change could result in approximately 12 properties experiencing flooding on part of their land parcels to depths greater than 300 mm during a 1 in 50 yr ARI rainfall event. As with the current scenario, the majority of flooding is away from buildings and it is uncertain whether this flooding is likely to enter habitable floors.

However, analysis indicates that predicted deep flooding on Beach Street during the future scenario may pose a risk to building interiors but without floor level surveys the risk remains uncertain (see Figure 8-8).

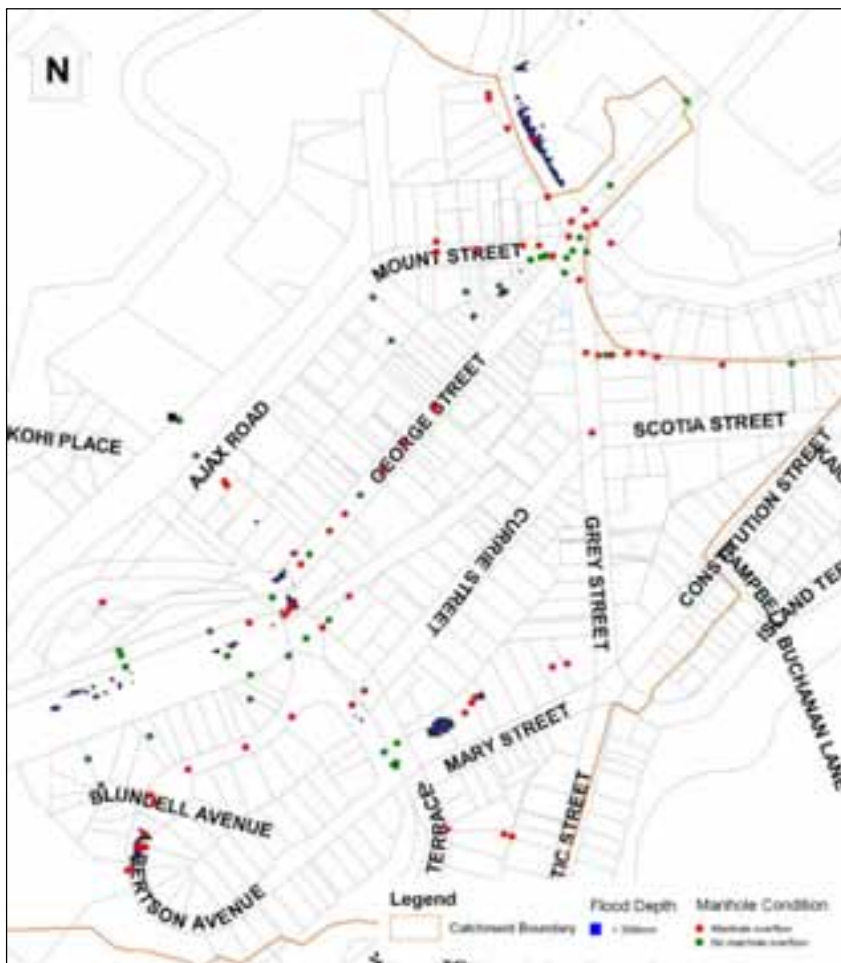


Figure 8-8: 2060 1 in 50 yr ARI Rainfall Event (Model Results)

#### 8.1.4.3 Flood Hazard

The hydraulic model has been used to predict flooding during two ‘emergency planning’ events: a 1 in 100 yr ARI rainfall event with current land use, and during a future worst case (extreme) climate change scenario. The results from the extreme planning scenario will allow DCC to put emergency planning measures in place to avoid future catastrophic effects within the catchment, and to identify where overland flow paths lie.

A predicted flood hazard rating has been calculated for the current and future (extreme) planning scenario during a 1 in 100 yr ARI event. A flood hazard rating is a factor of velocity and depth calculated from the hydraulic model results. It indicates the likely degree of flood hazard for a given area and the associated risk to the public. A definition of each Rating can be found in Table 8-3 below.



**Table 8-3: Flood Hazard Rating**

| Flood Hazard Rating | Degree of Flood Hazard | Flood Hazard Description                                                                    |
|---------------------|------------------------|---------------------------------------------------------------------------------------------|
| < 0.75              | Low                    | Caution – flood zone with shallow flowing water or deep standing water.                     |
| 0.75 – 1.25         | Moderate               | Dangerous for some – (i.e. children). Flood zone with > 250 mm deep, or fast flowing water. |
| 1.25 – 2.0          | Significant            | Dangerous for most – flood zone with 250 mm - 400 mm deep, fast flowing water.              |
| > 2.0               | Extreme                | Dangerous for all – flood zone with 400+ mm deep, fast flowing water.                       |



**Figure 8-9: 2010 1 in 100 yr ARI Rainfall Event (Model Results)**

The maximum flood hazard rating for the catchment during a current 1 in 100 yr ARI rainfall event is 'moderate' to 'significant', the main locations being George Street / Wickcliffe Street intersection and George Street / Beach Street. Of significance to the flood hazard rating in these locations is the deep (> 300 mm) ponding in the road during this event (Figure 8-9).



During a future 1 in 100 yr ARI rainfall event when the extreme planning scenario is applied, it is predicted that the total flood area will comprise approximately 6 % of the catchment, mostly in the roads or grass reserve to the west of the catchment and on Beach Street close to the port. During this event the maximum flood hazard rating remains 'moderate' to 'significant' with an increase in flood extents over the current scenario. This is shown in Figure 8-10.

During this future event the predicted flooding may pose a risk to pedestrian and vehicular traffic in the residential area to the west of the catchment (Albertson Avenue) and due to the depths of flooding the roads may become impassable and therefore access to some properties cut off. Some disruption to traffic on George Street (State Highway 88) may also occur.



Figure 8-10: 2010 1 in 50 yr ARI Rainfall Event (Model Results)



## 8.1.5 Network Age, Operation and Maintenance

### 8.1.5.1 Port Chalmers Catchment

Some operational issues relating to flooding have been identified by the DCC Network Management and Maintenance team and are described in the sections above. Further catchment specific issues relating to network operation and maintenance are described below.

#### Catchment Outfalls

The model results demonstrate that the stormwater outfalls in this catchment have limited effect on the stormwater systems' hydraulic performance. It is assumed that the outfalls are not fitted with flap valves (refer Section 4.7), however, if flap valves were installed it is unlikely there would be an improvement in hydraulic performance (Opus 2011b).

#### Wastewater Pump Stations

There are two wastewater pump stations in the Port Chalmers catchment with overflows to the stormwater network. These are discussed further in Section 8.2.

#### Catchpit Maintenance

Workshop discussions revealed that catchpit maintenance within the catchment may be an issue. DCC Network Management and Maintenance staff indicated that the catchpits at the intersection of George Street / Wickliffe Terrace (north) are significant and if not regularly cleaned can cause ponding at the intersection to worsen during rainfall.

### 8.1.5.2 City-Wide

As outlined in Section 4.7.6, depending on the location, catchpit and inlet maintenance is undertaken by a number of different teams with variations in inspection specification. This means that city-wide, there are variations in catchpit levels of service. During autumn months in particular, heavy rainfall can result in debris blocking the catchpits and inlet screens. A reduction in catchpit capacity due to silt build up can lead to extension of ponding durations and extents during a rainfall event. Similarly, blocking of inlet screens (of culverts or catchpits) prevents flow entering the network, also resulting in extended ponding, as well as increasing overland flow to other locations. This was verified by Network Maintenance and Management staff as a potential issue during walkovers and workshops.

## 8.1.6 Culture and Amenity

Some predicted flooding in this catchment will occur within the George Street Heritage Precinct although adverse effects to the Precinct are unlikely. A number of District Plan designations may also be affected; of note is the school on Albertson Avenue where nuisance flooding may cause some disruptions at this location to pedestrian and vehicular access. Further to this, a variety of locations are listed as wellbeing locations; with major economic and minor social wellbeing locations throughout the catchment (see Figure 4-12). These areas are also predicted to be affected by flooding although the effects are considered to be minor as any disruption to normal activities in these locations is unlikely.



### 8.1.7 Summary of Effects of Stormwater Quantity

A summary of the effects of stormwater quantity is as follows:

- The modelling results indicate that 67 % the stormwater network in the Port Chalmers catchment has the ability to accept rainfall from a 1 in 10 yr ARI event during MHWS tide conditions, with some areas having less capacity.
- Network capacity restrictions are predicted in some locations during events as small as a 1 in 2 yr ARI rainfall event.
- During a current 1 in 10 yr ARI rainfall event, the network capacity is further constrained primarily due to insufficient pipe capacity and nuisance flooding is predicted in a number of locations.
- Whilst tidal influence on the network is not considered to be significant, small increases in flood depth are predicted in the east of the catchment due to tidal boundary conditions applied to the model.
- During a current 1 in 50 yr ARI rainfall event, approximately nine land parcels are predicted to be at risk of deep flooding ( > 300 mm), rising to 12 when the future scenario is applied. The predicted deep flooding is unconfirmed and generally away from properties, therefore the risk of habitable floor flooding of buildings is considered to be low in these instances.
- During a current 1 in 100 yr ARI rainfall event, predicted maximum flood hazard rating for the catchment is 'moderate' to 'significant', the main locations being George Street / Wickliffe Street intersection and George Street / Beach Street. Of significance to the flood hazard rating in these locations is the deep (> 300 mm) ponding in the road during this event
- During a future 1 in 100 yr ARI rainfall event, with the application of an extreme climate change scenario with sea level rise and storm surge, the model predicts that flood hazard ratings remain 'Moderate to Significant' but that the extent of flooding increases. Approximately 6 % of the catchment is inundated, mostly in the roads or grass reserve to the west of the catchment and on Beach Street close to the port.
- The model results demonstrate that the stormwater outfalls in this catchment have limited effect on the stormwater systems hydraulic performance.
- Inconsistencies in the standard and frequency of cleaning and maintenance of stormwater structures could exacerbate or transfer predicted flooding; of significance in this catchment are the catchpits at the intersection of George Street / Wickliffe Terrace (north).



### 8.2 Stormwater Quality

Stormwater quality is discussed in detail in Section 6. Annual monitoring of the quality of the stormwater discharged from the Port Chalmers catchment, conducted using a grab-sample technique, has been undertaken (2007 to 2010) with a time-proportional sample set also collected from the Port Chalmers catchment network in 2010.

The following is a summary of the annual stormwater monitoring results. The observations must be viewed in the context of a very small dataset and the limitations of the grab-sampling method (discussed below).

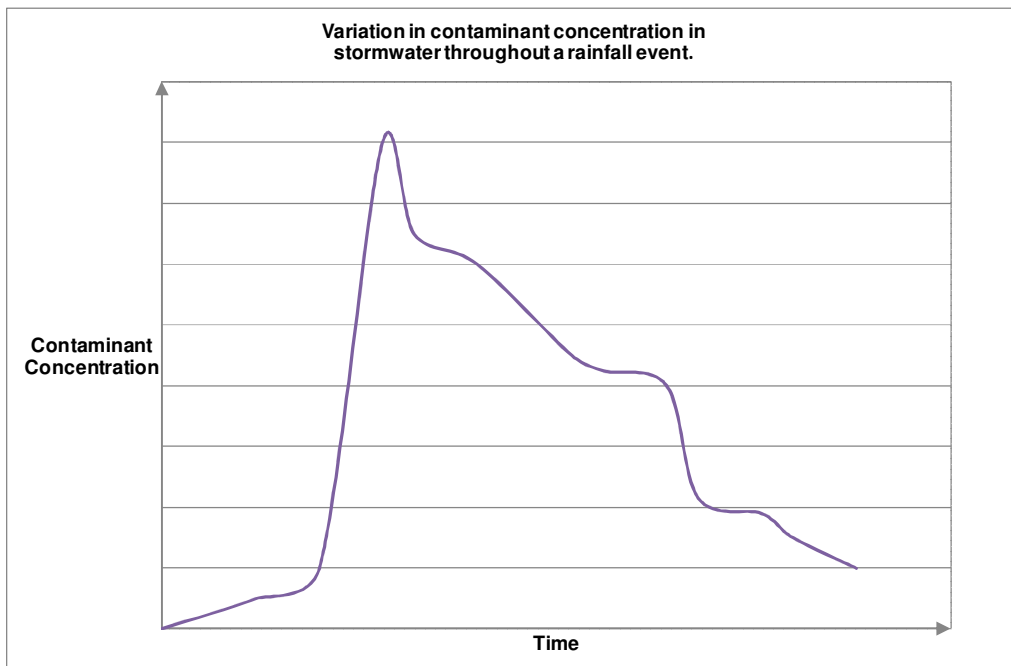
- The levels of contaminants in the stormwater from the outfalls in this catchment are generally low and below levels typical of stormwater quality from similar catchments, with the exception of a single measurement of faecal coliforms in 2007 from the Watson Park outfall.
- The elevated faecal coliform measurement does not correspond with any wastewater complaints or known incidents of wastewater pump station overflow (refer Section 8.2.1).

Whilst the levels of contaminants measured in the stormwater from the Port Chalmers catchment has generally been low, the data has been variable. This may be due to variable conditions within the catchment at the time of sampling but may also be due use of grab samples to monitor the stormwater. Grab sample results give a 'snapshot' of the stormwater quality at one point in time only. Throughout a storm event, the concentration of contaminants within the stormwater varies depending on the time since the start of the event. This is indicated in Figure 8-11.

The time that grab samples are taken during the storm event can significantly affect the results. While stormwater samples taken were targeted at sampling the 'first flush', and consent conditions detailed required storm size and antecedent conditions, it is not known when, during a rainfall event, the stormwater monitoring grab samples were taken for each monitoring year. It is possible that they were taken at differing times during rainfall events, hence the data variability and lack of clear trends.

Time proportional monitoring of stormwater quality yields results that provide a more accurate profile of contaminant concentrations within the stormwater from the catchment.

A single time-proportional sample of the stormwater discharged from the Port Chalmers catchment (Watson Park outfall) was taken in 2010. The results of this sampling indicated the low levels of contaminants in the stormwater, generally below the range typically observed from when compared with stormwater data from the variety of sources. (Microbial contamination was not measured in these samples).



**Figure 8-11: Concentration of Contaminants in Stormwater for Duration of a Rainfall Event**

(Based on time-proportional sampling carried out in Dunedin)

## 8.2.1 Potential Wastewater Contamination

### 8.2.1.1 Stormwater Quality

The potential source of microbial contamination in the 2007 stormwater sample from this catchment is difficult to distinguish. Measured peaks in levels of FWAs, an indicator of human wastewater contamination, do not correspond with peaks in the microbial contamination of the stormwater. Therefore contamination by human wastewater cannot be concluded with any certainty.

Whilst there are a number of wastewater complaint records for this catchment, none correspond with the elevated microbial contamination of the stormwater measured in 2007.

The elevated microbial levels measured in 2007 appear to be an isolated incident. Ongoing stormwater quality monitoring will verify if there is ongoing wastewater input to the stormwater system.

### 8.2.1.2 Wastewater Pump Station Emergency Overflows

There are two wastewater pump stations in the Port Chalmers catchment with overflows to the stormwater network. This may present a risk to stormwater quality in this catchment.

The Mussel Bay pump station, to the west of the catchment, has an emergency overflow from the wet well to the adjacent stormwater line. The Mount Street pump station, to the east of the catchment has an emergency overflow to the adjacent stormwater line in a manhole a short distance upstream (refer Section 4.9).

There are currently no significant issues with the emergency overflows from either pump station. Frequency analysis was carried out during wastewater investigations for Phase 2 of the 3 Waters project and examined operation up to and including a 1 in 50 yr ARI rainfall event. The analysis



indicated that the emergency overflows of both pump stations are unlikely to operate due to capacity issues up to and including a 1 in 50 yr ARI rainfall event. It may operate however, in the event of pump failures. Furthermore, DCC Water and Waste Business Unit staff confirmed that there were no known instances of emergency overflow operation in the recent past.

### **8.2.2 Harbour Water Quality**

The quality of the harbour water will be affected by numerous contaminant sources including, but not limited to, stormwater discharges from the entire harbour catchment, marine vessels and other marine users. Currently, harbour water quality is not monitored by DCC and as such there is no clear link between the quality of stormwater leaving the outfall and the quality of the water in the harbour.

While no national or international guidelines are available for stormwater discharge quality, ANZECC (2000) guidelines are available for harbour water quality (as well as harbour sediment quality), which identify concentrations of contaminants within the marine environment under which 80 % or 99 % of species are protected.

Because of the different contaminant sources identified above, and the dilution that occurs when stormwater enters the marine environment, in order to fully utilise these guidelines, marine water monitoring would need to be undertaken alongside stormwater quality monitoring, and links established between stormwater discharge points and marine water quality within the harbour. Further clarity with respect to longer term environmental effects could then be established using sediment quality information.

Marine water quality is also highly variable both spatially and temporally, and sampling results would also only provide a 'snapshot' of water quality. Many factors influence the water quality, including dilution and dispersion; freshwater inputs; rainfall events; and tidal currents.

### **8.2.3 Harbour Sediment Quality**

Contaminants in urban stormwater entering the marine environment potentially pose a risk to the health of marine organisms, primarily through the accumulation of the contaminants in marine sediments. Contaminants in the stormwater adhere to suspended particles and sediments in the marine environment and accumulate in the marine bed. High levels of contaminants within the sediments may result in adverse impact on marine flora and fauna which come into contact with those sediments.

To assess the potential effects of contaminated sediments on marine ecology, the contaminant concentrations within the sediments can be compared to sediment quality guidelines. It should be noted however, that guidelines provide indicative rather than conclusive evidence of adverse effects; any exceedence of the guidelines therefore indicates only a potential for adverse effects.

ANZECC (2000) sediment quality guidelines provide low and high trigger values. The low values are indicative of contaminant concentrations where the onset of adverse biological effects may occur, thus providing early warning and the potential for adverse environmental effects to be prevented or minimised. The high values are indicative of contaminant concentrations where significant adverse biological effects may be observed. Exceedence of these values could therefore indicate that adverse environmental effects may already be occurring.

#### **8.2.3.1 Port Chalmers Catchment**

Measurement of marine sediment contaminant levels is not required under the resource consent consents conditions for the stormwater discharges from this catchment. However, sediments have been collected from < 20 m and > 20 m from the Watson Park outfall in 2010. The contaminant levels



within the sediments adjacent to the Watson Park outfall in the Port Chalmers catchment are discussed in detail in Section 5.

To summarise, the levels of contaminants measured in the sediments in the vicinity of the Watson Park outfalls in 2010 were generally low. However, closer to the outfall (< 20 m), lead and PAHs were found to be slightly above the ANZECC low trigger value and at distance from the outfalls (> 20 m), arsenic was found to be at the ANZECC low trigger value.

The results of the annual stormwater monitoring (grab samples) and the single time-proportional data set do not indicate levels of contaminants which are cause for concern and levels of lead, arsenic and oil and grease are not elevated.

It is difficult therefore to draw conclusions as to the source of potential marine sediment contamination, particularly with only a single data set. The harbour in this location currently receives stormwater from residential / commercial land uses and parts of the railway. However, in the past a tannery was located in this area and until the late 1970's effluent from the tannery was discharged into Sawyers Bay. This may have contributed to historic contamination of the sediments in this location (Probert, 1990a) and may be reflected in the sediment sampling results, particularly further from the outfall.

#### 8.2.3.2 Harbour-Wide

Harbour-wide, trends in the levels of contaminants in the sediment remain unclear with just four years worth of monitoring data in the Upper Harbour Basin revealing high variability among contaminant levels and sites. Many contaminants are present in the sediments at various sites within the harbour at levels exceeding the ANZECC sediment guideline low trigger values.

However, the majority of harbour sediment monitoring has been carried out in the Upper Harbour Basin and not in the vicinity of Port Chalmers, which is 8 km from the Upper Harbour basin and isolated from other DCC stormwater inputs.

Further monitoring of sediments harbour-wide is required to better understand the levels of contamination and establish whether any long term trends exist. However, there is little evidence to suggest that stormwater quality from the Watson Park outfall is of concern and so it is considered that the risk to sediment deterioration due to the stormwater discharge in this location is low.

#### 8.2.4 Marine Ecology

There are no consenting requirements for biological monitoring associated with the stormwater discharges from this catchment. However, there is limited historical biological data for the Port Chalmers catchment and an ecological assessment was carried out for the 2010 study at the Watson Park outfall.

The historical information can be summarised as follows:

- Benthic communities in and around Port Chalmers are generally similar to those of mud bottoms throughout the Otago Harbour.
- The intertidal zone around Port Chalmers appears to harbour organisms similar to other rocky shore communities within Otago Harbour.
- Rocky shore communities around Port Chalmers are more diverse than in the Upper Harbour Basin but less diverse than those further out in the harbour and on naturally occurring rocky shores.



The results of the 2010 ecological assessment at Watson Park outfall can be summarised as follows:

- Infauna survey was not possible as any suitable substrate was deemed to be too far away from the outfalls to be directly influenced by the stormwater discharges.
- Macroalgae was virtually absent.
- Epifauna was moderately abundant, dominated by barnacles, and was higher closer to the outfalls. Diversity of epifauna was relatively low.

Determining the ecological effects of contamination in the harbour environment is difficult. Unless contamination levels are very high within the sediments it is difficult to distinguish between the potential adverse effects of contamination from stormwater, contamination from other sources, and the effects of other environmental variables.

The 2010 study concluded that the outfalls for the Port Chalmers catchment are not in locations with a suitable environment to adequately assess the ecology, and that there is a lack of data available relating to the Port Chalmers catchment. It is therefore not possible to identify any clear trends in the state of the ecology in the receiving environment.

### 8.2.5 Culture and Amenity

The harbour environment around Port Chalmers is an important area for recreation with a number of boat clubs and tourism operators in the area. A decline in the quality of the harbour environment could adversely impact on recreational activities.

Historically the harbour has been used by Kāi Tahu and their descendents and the discharge of stormwater and associated contaminants has the potential to significantly impact Kāi Tahu values and beliefs.

Due to a lack of monitoring data to date there is little evidence to suggest that the quality of the harbour continues to deteriorate significantly. However, stormwater monitoring results indicate that the quality of stormwater from the Port Chalmers catchment is not significantly contributing to any deterioration in quality of the harbour environment.



### 8.2.6 Summary of Effects of Stormwater Quality

A summary of the effects of stormwater quality is as follows:

- The contaminant levels measured in the stormwater discharged from the Port Chalmers catchment are low and generally below levels that are considered to be typical from residential / commercial catchments.
- An isolated measurement of elevated faecal coliforms in the stormwater from the Watson Park outfall was recorded in 2007. The potential source and evidence of wastewater contamination for this remains inconclusive.
- The results of the single time-proportional monitoring from the Port Chalmers catchment did not indicate any cause for concern with respect to the quality of stormwater from this catchment.
- There are two wastewater pump stations in the catchment with emergency overflows to the stormwater network. However, these are not anticipated to operate during events smaller than a 1 in 50 yr ARI rainfall event.
- Harbour water quality is not currently monitored. Monitoring would allow comparison with ANZECC (2000) marine water quality guidelines and allow a link to be established between stormwater discharge quality and harbour water quality.
- Lead and PAH levels in sediments sampled near the Watson Park outfall were measured above ANZECC low trigger values in 2010. It is likely that the sediment contamination could be historical although this remains unconfirmed.
- In the Upper Harbour Basin levels of key contaminants in the sediments were found to be slightly lower in 2010 than previous monitoring years. Further monitoring is required to better understand the contamination levels and establish any long term trends.
- The ecological data is insufficient to draw any conclusions regarding the biological health of the harbour in Port Chalmers.
- The harbour area, in particular around Port Chalmers, has important cultural values and is an important area for recreation. The results of investigations to date do not indicate that harbour quality is continuing to deteriorate as a result of the quality of stormwater from this catchment.



## 9 Catchment Problems and Issues Summary

Following the Assessment of Environmental Effects (AEE), and identification of catchment specific targets for stormwater management, a number of key problems and issues can be identified in the Port Chalmers catchment, and prioritised for action. These are discussed below. Section 10 prioritises these issues, and the remainder of this ICMP involves target setting and development of options to manage the stormwater from this catchment. Figure 9-1 presents the key issues for the Port Chalmers catchment.

### 9.1 Stormwater Quantity Issues

#### 9.1.1 Low Level of Service

Insufficient network capacity creates overflows in events as small as a 1 in 2 yr ARI rainfall event in certain parts of the catchment. Other areas have levels of service restricted to a 1 in 5 yr ARI rainfall event. Modelling results indicate that approximately 67 % of the stormwater network in the Port Chalmers catchment has the ability to accept rainfall from a 1 in 10 yr ARI event during MHWS tide conditions.

#### 9.1.2 Nuisance Flooding

Nuisance flooding (between 50 mm and 300 mm deep) is predicted in the road in Albertson Avenue to the west of the catchment a 1 in 2 yr ARI rainfall event. A number of locations are predicted to experience nuisance flooding during rainfall events of greater than a 1 in 5 yr ARI however the effects are not considered significant. During a 1 in 10 yr ARI rainfall event or greater, flooding is predicted to extend the full width of the road in certain locations and may cause nuisance to pedestrians and vehicular traffic.

#### 9.1.3 Deep Flooding

Deep flooding (> 300 mm deep) is predicted to occur at a number of locations during events as small as a 1 in 10 yr ARI rainfall event, however it is unlikely to pose a threat to building interiors. The number of land parcels predicted to be at risk of habitable floor flooding increases with rainfall events of increasing recurrence interval. However, in most locations the risk to building interiors is considered to be low. This is because the flooding is predicted to be on land parcels away from buildings, or locations where flooding is unconfirmed and confidence in the model is low.

#### 9.1.4 Flood Hazard – Current and Future 1 in 100 yr ARI

The model shows that during a 1 in 100 yr ARI rainfall event, with MHWS tide conditions, Albertson Avenue and Beach Street are predicted to experience flooding across the full width of the road, with deep flooding (> 300 mm) predicted on parts. Traffic disruptions may also be experienced on George Street (State Highway 88). A 'moderate' to 'significant' flood hazard rating has been assigned to these locations. With the extreme climate change scenario applied (with a storm surge) the area of 'moderate' to 'significant' flood hazard rating increases in extent in these locations.



### 9.1.5 Network Maintenance

City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in levels of service. This has the potential to exacerbate or transfer flooding.

Several catchpits in the catchment are known to be prone to blockage and exacerbate flooding within the road. Of significance in this catchment are the catchpits at the George Street / Wickliffe Street intersection.

### 9.2 Stormwater Quality Issues

It is clear that within the harbour in general there is historical sediment contamination likely to be from a combination of the stormwater outfalls and other sources.

Although there is potential for ongoing contamination of the sediment from stormwater, to date the stormwater monitoring results do not present cause for concern and it has not been possible to establish a causal link from available data.

At the Watson Park outfall within the Port Chalmers catchment, sediment data collected in 2010 has indicated low levels of a number of contaminants (when compared with ANZECC sediment quality guidelines). However, lead and PAHs have been present in moderate amounts (above ANZECC guideline low trigger levels), at sample sites within 20 m of the outfall and arsenic was measured above ANZECC guideline low trigger levels at a distance of > 20 m from the outfall. However a single data set is insufficient to gauge the quality of marine sediments.

#### 9.2.1 High Variability of Stormwater Quality Results

Variability in stormwater quality results mean that no clear trends are seen in stormwater quality, nor can key contaminants be confidently identified to aid stormwater management.

However, the annual stormwater monitoring results and single time-proportional sample taken in the Port Chalmers catchment do not indicate any contaminants of concern are being generated in high levels in this catchment.

#### 9.2.2 Limited Confidence in the Knowledge of Effects on the Otago Harbour Environment

Data relating to the effects on the environment in the Port Chalmers area is sparse. The current monitoring regime undertaken to meet consent conditions provides limited confidence in the following:

- The extent of historic versus current / ongoing harbour sediment contamination; and
- Links between stormwater quality, sediment quality, and the health of the harbour environment.



### 9.2.3 Ongoing Stormwater Discharge

Stormwater quality monitoring indicates that the stormwater quality discharged from the Port Chalmers catchment appears to be typical of an urban and mixed land use catchment and to date the contaminant levels in the stormwater have been relatively low with one exception in 2007 (see Section 9.2.4). Indications from recent monitoring do not show that current stormwater discharges are having an obvious adverse effect on the receiving environment. However as discussed above, there is limited confidence in some of this information, and further data may be required to validate this.

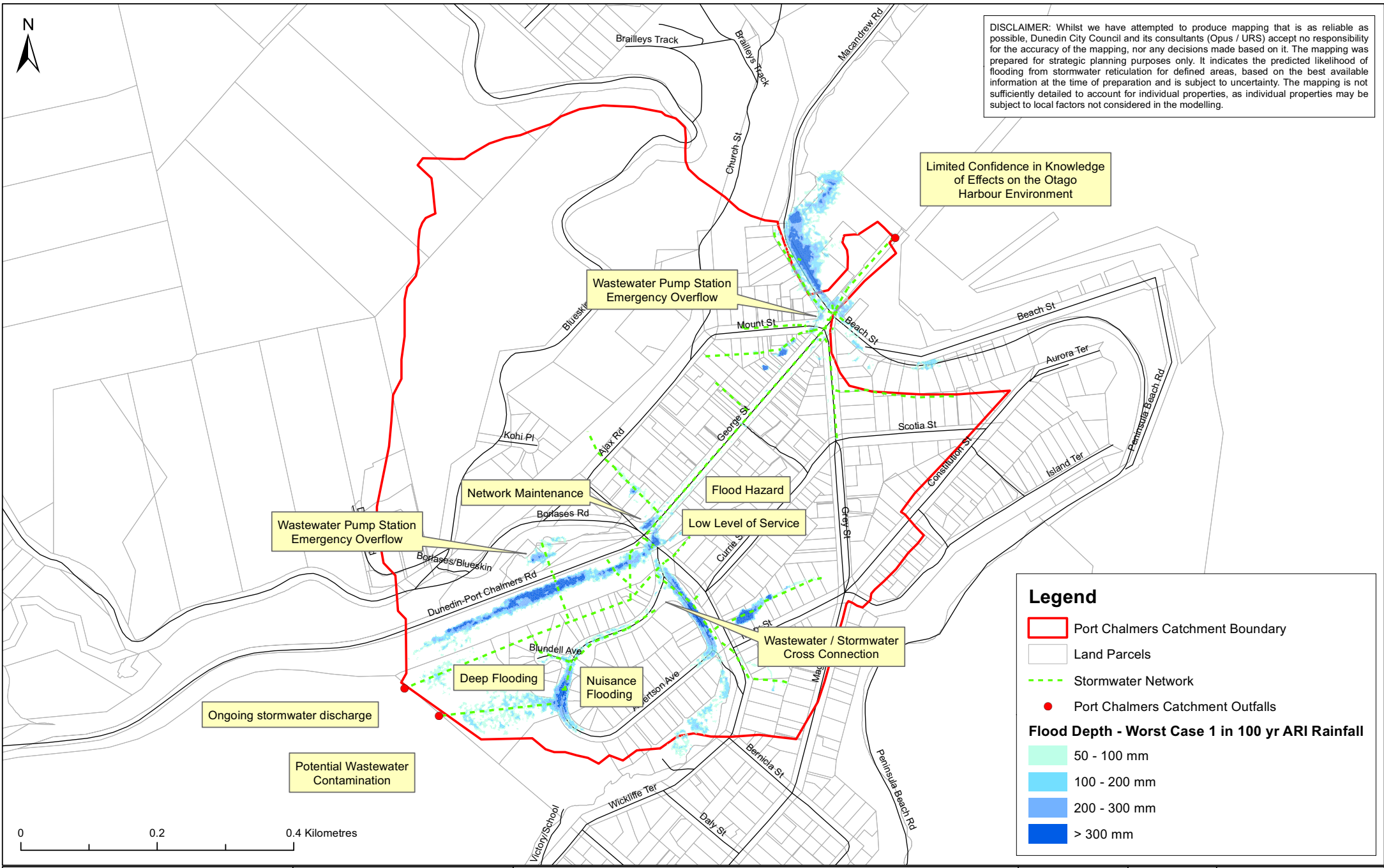
Mechanisms already in place (e.g. the Dunedin Code of Subdivision and Development and the Trade Waste Bylaw) are designed to encourage source control in order to ensure that contaminant levels in the stormwater discharge do not increase, and that new development and existing land uses are managing stormwater quality in an appropriate manner into the future.

### 9.2.4 Potential Wastewater Contamination

Stormwater quality monitoring (2007-2010) indicates an isolated incident of high levels of microbial contamination, at or above the upper limit typical for stormwater in the Port Chalmers stormwater discharge from Watson Park in 2007. The source of this contamination is uncertain.

### 9.2.5 Wastewater Emergency Overflows

There are two wastewater pump station emergency overflows to the stormwater network in the Port Chalmers catchment which may operate in the event of pump failure or when extreme (> 1 in 50 yr ARI) rainfall events are experienced.



**Dunedin 3 Waters Strategy**

**PORT CHALMERS INTEGRATED CATCHMENT MANAGEMENT PLAN**

**Figure 9-1**

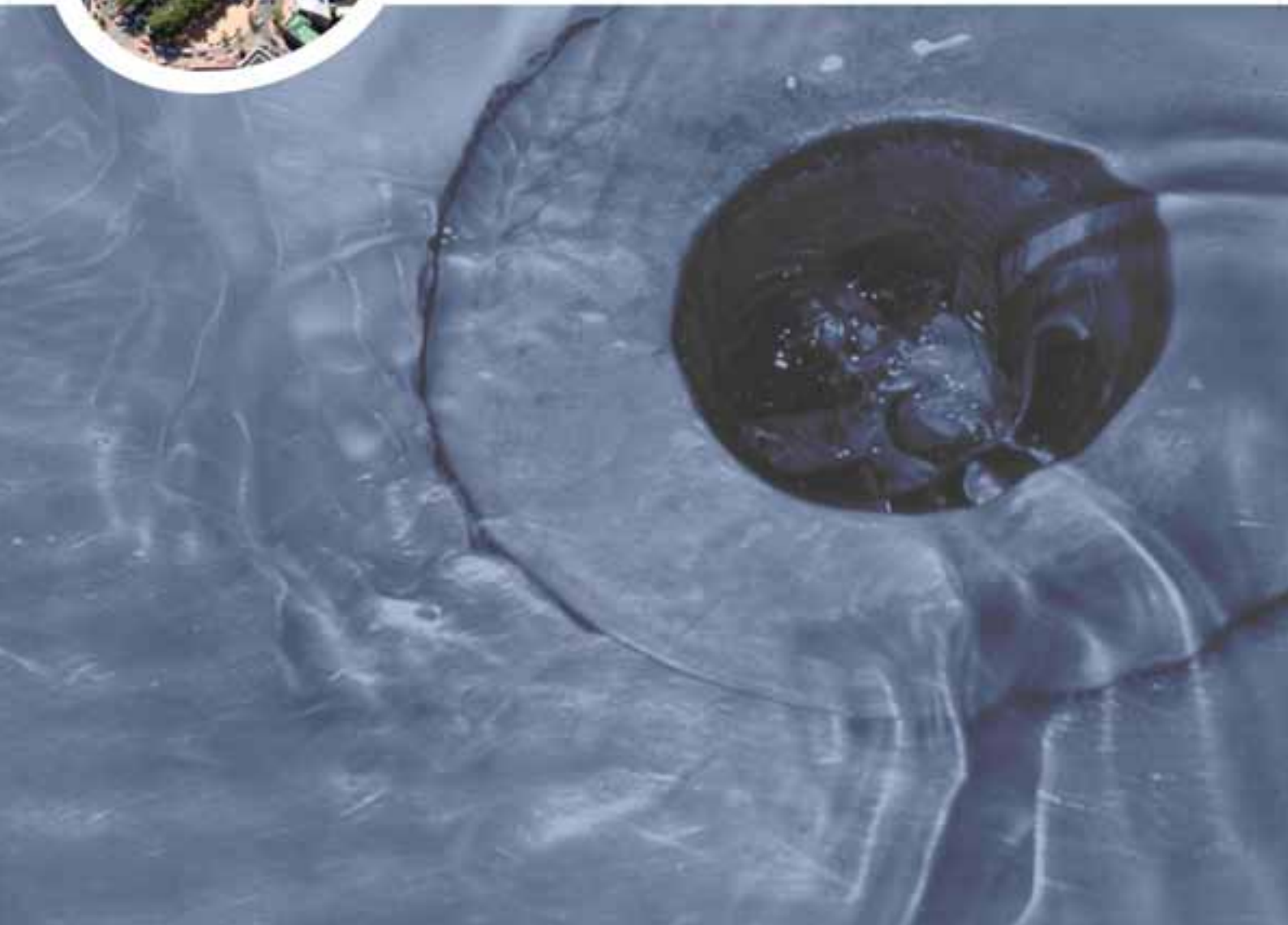
**Port Chalmers Catchment Issues**

|                                        |           |          |            |            |
|----------------------------------------|-----------|----------|------------|------------|
| <b>DISCIPLINE</b><br><b>Stormwater</b> | Drawn:    | JMH      | Status:    | Final      |
|                                        | Checked:  | HES      | Scale:     | 1:5,000    |
|                                        | Approved: | HES      | Job. No:   | 42173227   |
|                                        | Date:     | Sep 2011 | Map No:    | Figure 9-1 |
|                                        |           |          | Plot Date: | Sep 2011   |
|                                        |           |          | Revision:  | -          |



## Part 4

### Targets







## 10 Issues Prioritisation

DCC have developed a decision making framework (refer Appendix E) in line with the New Zealand and Australian risk management framework AS/NZS 4360 to enable the comparison of issues and options. A Consequence and Likelihood rating has been applied to each of the issues identified to provide a risk matrix score, leading to a definition of problem management. Figure 10-1 shows the risk matrix used in this scoring. Other information relating to definitions for Consequence and Likelihood are provided in the analysis of each issue, and the guidelines on this are provided in Appendix E.

Table 10-1 provides a list of the main issues identified for the Port Chalmers catchment, and a risk and consequence score for each, resulting in a 'manage passively' or 'manage actively' categorisation. The passive or active management categorisation then drives the catchment specific management approach for each issue, and later the options considered. Active management indicates that DCC will seek to implement changes to stormwater management in the catchment, whereas passive management would tend more towards monitoring and review of existing management practices to ensure that the targets set can be met.

| RISK<br>LIKELIHOOD        | CONSEQUENCE                               |                                          |                                           |                                           |                                           |
|---------------------------|-------------------------------------------|------------------------------------------|-------------------------------------------|-------------------------------------------|-------------------------------------------|
|                           | Negligible<br>(1)                         | Minor<br>(10)                            | Moderate<br>(40)                          | Major<br>(70)                             | Catastrophic<br>(100)                     |
| <b>Almost Certain (5)</b> | <b>Low (5)</b><br>Manage Passively        | <b>Moderate (50)</b><br>Manage Passively | <b>Very High (200)</b><br>Manage Actively | <b>Extreme (350)</b><br>Manage Actively   | <b>Extreme (500)</b><br>Manage Actively   |
| <b>Likely (4)</b>         | <b>Low (4)</b><br>Manage Passively        | <b>Moderate (40)</b><br>Manage Passively | <b>Very High (160)</b><br>Manage Actively | <b>Very High (280)</b><br>Manage Actively | <b>Extreme (400)</b><br>Manage Actively   |
| <b>Possible (3)</b>       | <b>Negligible (3)</b><br>Manage Passively | <b>Moderate (30)</b><br>Manage Passively | <b>High (120)</b><br>Manage Actively      | <b>Very High (210)</b><br>Manage Actively | <b>Very High (300)</b><br>Manage Actively |
| <b>Unlikely (2)</b>       | <b>Negligible (2)</b><br>Accept           | <b>Low (20)</b><br>Manage Passively      | <b>High (80)</b><br>Manage Actively       | <b>High (140)</b><br>Manage Actively      | <b>Very High (200)</b><br>Manage Actively |
| <b>Rare (1)</b>           | <b>Negligible (1)</b><br>Accept           | <b>Low (10)</b><br>Accept                | <b>Moderate (40)</b><br>Manage Passively  | <b>High (70)</b><br>Manage Actively       | <b>High (100)</b><br>Manage Actively      |

### Note

The Risk Matrix includes an indication of the minimum acceptable treatment strategy. In all cases the option of avoiding the risk should be considered first.

Figure 10-1: Risk / Consequence Matrix for Issues Prioritisation



Table 10-1: Issues Prioritisation

| Issue                                                                       | Consequence Rating | Likelihood Rating | Discussion                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Risk Matrix Score | Management Approach |
|-----------------------------------------------------------------------------|--------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|---------------------|
| Limited Confidence in Knowledge of Effects on the Otago Harbour Environment | 40                 | 4                 | <p>Past sampling programmes provide inconclusive data which means that the ongoing effects of stormwater discharges are unclear. Without better knowledge, DCC will be unable to meet its strategic objectives and ensure ongoing sustainable stormwater management. However, stormwater quality data suggests risk is low for the Port Chalmers catchment.</p> <p>Failure to establish clear links between stormwater quality and receiving environment quality may weaken DCC's position both legally and in terms of public perception.</p> | 160               | Manage Actively     |
| High Variability of Stormwater Quality Results                              | 40                 | 3                 | <p>Stormwater quality monitoring could be made more robust. Relatively low / moderate confidence in data. Without better knowledge, underpinned by good quality data, DCC cannot reliably meet its strategic objectives.</p> <p>Discharges from the Port Chalmers catchment have, however, show relatively low levels of contaminants over the monitoring period (2007-2010).</p>                                                                                                                                                              | 120               | Manage Actively     |
| Network Maintenance                                                         | 10                 | 5                 | Inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures. Potential to exacerbate flooding effects.                                                                                                                                                                                                                                                                                                                                                                                                     | 50                | Manage Passively    |
| Nuisance Flooding                                                           | 10                 | 4                 | Flooding predicted in a number of locations, predominantly in road corridor. Likely to increase in future, predominantly due to projected climate change. Currently occurring but during high frequency events (1 in 2 yr ARI) effects are considered to be minor.                                                                                                                                                                                                                                                                             | 40                | Manage Passively    |
| Low Level of Service                                                        | 10                 | 4                 | <p>The current level of service in some areas is below DCC's target for new infrastructure, as a result of inadequate network capacity and, to a lesser extent, tidal influence, some nuisance flooding effects are predicted.</p> <p>Effects will be exacerbated by climate change; therefore adaptation is required in order to meet future long term objectives of no increase in properties at risk of flooding due to climate change.</p>                                                                                                 | 40                | Manage Passively    |



| Issue                                             | Consequence Rating | Likelihood Rating | Discussion                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Risk Matrix Score | Management Approach |
|---------------------------------------------------|--------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|---------------------|
| Flood Hazard – Current and Future 1 in 100 yr ARI | 40                 | 1                 | Areas of 'moderate' to 'significant' flood hazard currently in roadways. Deep flooding predicted in locations within the catchment under current conditions. Future extreme climate change effects pose further threat. It is predicted that by 2060 during extreme weather and tide events there will be a 'moderate' to 'significant' hazard across a larger extent of the catchment. The extent of the threat is uncertain as there is unknown certainty around climate change predictions. | 40                | Manage Passively    |
| Ongoing Stormwater Discharge                      | 10                 | 4                 | Ongoing discharge of stormwater (and associated contaminants) to the harbour. The extent of contamination is unconfirmed, but available data indicates that contaminants discharged are typical of land use, and the consequences are minor. Current discharges not believed to be as significant an issue as historical contaminant issues from a variety of sources.                                                                                                                         | 40                | Manage Passively    |
| Potential Wastewater Contamination                | 10                 | 4                 | High microbial levels, above typical levels measured in stormwater in 2007 only. Appears to be isolated incident therefore low risk of contamination but difficult to establish a source. Major Stakeholder issue.                                                                                                                                                                                                                                                                             | 40                | Manage Passively    |
| Deep Flooding                                     | 10                 | 3                 | Deep flooding predicted in a small number of locations during events 1 in 10 yr ARI and 1 in 50 yr ARI. Risk to building interiors low. Number of properties at risk is not likely to significantly increase due to climate change.                                                                                                                                                                                                                                                            | 30                | Manage Passively    |
| Wastewater Emergency Overflows                    | 10                 | 2                 | Two pump stations with emergency overflows to the stormwater network. Operation infrequent, good state of knowledge of operation. Potential failure to meet DCC's Strategic Objectives (infrequent).                                                                                                                                                                                                                                                                                           | 20                | Manage Passively    |



## 11 Catchment Specific Targets and Approaches for Stormwater Management

Figure 11-1 provides a breakdown of the link between stormwater management issues identification, objectives development and the setting of targets.

The information presented in the AEE section of this report has been used to identify the key stormwater management issues for the Port Chalmers catchment. These issues have been prioritised and ranked, according to DCC's risk matrix, which looks at the consequence and likelihood of each issue.

For each issue, DCC's commitment (in terms of strategic stormwater objectives) will be examined, and a catchment specific approach outlined depending on both the strategic objectives, and the issue's priority. SMART targets are then set to guide the design of options, and also to measure the success of the catchment management approach.

Following this section, stormwater management options are developed to ensure targets are met.

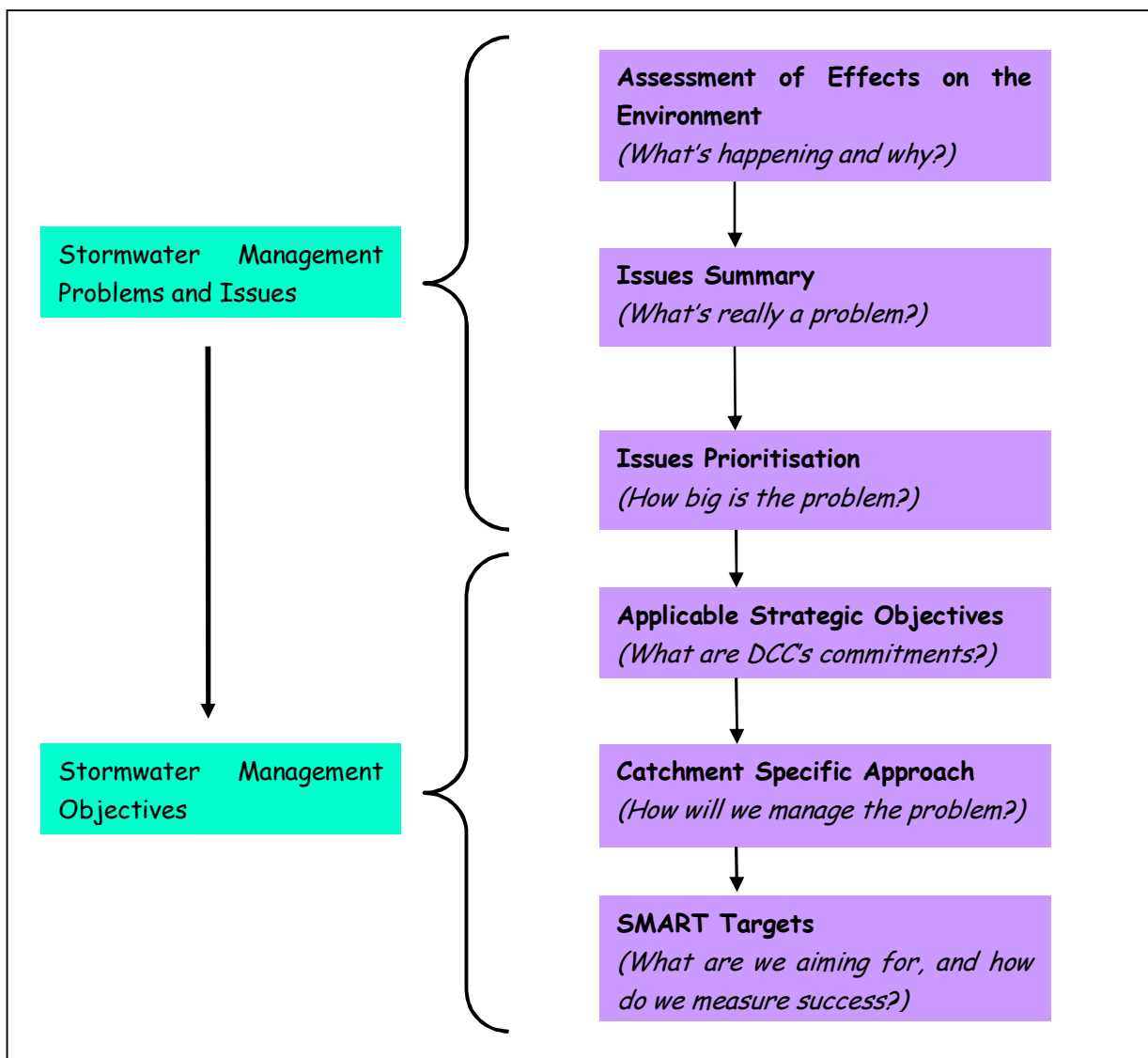


Figure 11-1: Target Development Process



Management approaches and targets are essential for providing information to ensure appropriate funding is made available for stormwater management, and that the management options implemented provide the best value for money to the community. A number of other ICMPs are being prepared by DCC for other outfalls discharging to the harbour. Similar targets will be developed for these ICMPs, and ultimately, issues prioritisation will be used to compare and prioritise recommendations across the catchments.

The catchment specific stormwater management approach is driven by the issues prioritisation, and provides guidance for options development in terms of a broad management approach for each issue, specific to each catchment. Management approaches are driven strongly by the applicable long term (50 year) strategic objectives, outlined in Section 2.

Stormwater management 'SMART' targets are an important tool for DCC; these follow a set of guidelines to ensure that they are well-defined and attainable, as outlined below:

- **Specific** – well defined and clear targets, able to be understood;
- **Measurable** – to provide feedback to continually improve performance;
- **Achievable** – to ensure success;
- **Realistic** – within available resources, knowledge and time; and
- **Time-Bound** – to monitor progress on a number of timescales, and ensure time is available to achieve the goals.

Targets relate both to long and short term objectives outlined in Section 2, depending on the issue. For example, they may refer to maintenance of a certain level of service for the stormwater network, or commitments to minimise adverse effects on the receiving environment where appropriate. The AEE also guides the setting of targets. As some targets may be linked to monitoring information, it is essential that these targets are open to review and adjustment over time. Ongoing monitoring results may indicate a greater or lesser environmental impact than currently understood.

Tables 11-1 and 11-2 outline catchment specific approaches and SMART targets for each of the key stormwater issues identified in the Port Chalmers catchment.

### 11.1 Stormwater Quantity Targets and Approaches

Table 11-1 presents a summary of stormwater management key effects relating to stormwater quantity, and catchment specific targets set for Port Chalmers. Approaches and targets developed for 'active' and 'passive' management of stormwater quantity issues in the Port Chalmers catchment are discussed in more detail below.



### 11.1.1 Network Maintenance

The maintenance and cleaning of catchpits and other stormwater structures is an essential part of maximising the efficiency and level of service of the stormwater network. As the owners of the network, DCC need to be certain that the asset is being maintained appropriately. The task of maintaining stormwater inlet assets is currently split between three DCC departments, and one national authority. Contracts for maintenance of catchpits and inlet structures have some differences in terms of performance criteria. Additionally, there would be benefit in identifying key assets as part of the catchment management process in order to focus maintenance and cleaning efforts further.

The target set for this issue is to first develop an understanding of the current level of maintenance and cleaning, and then, if required, recommend changes in order to focus efforts and optimise inlet efficiency of the stormwater network.

### 11.1.2 Nuisance Flooding

Nuisance flooding resulting from a low level of service is predicted and confirmed in four main areas in the Port Chalmers catchment. However, the predicted flood extents are mainly confined to the road and as such are unlikely to have a significant impact on the activities within this catchment.

A number of complaint records exist for this catchment, verifying nuisance flooding. However, in most cases the size of the storm event during which the complaints were made is not known and the historical data collection methods used for customer complaints logging has resulted in variable information on complaints. Improvements in complaints recording will result in a clearer picture of customer satisfaction in the future.

In general, the council will adopt a long term approach to improving network performance and adapting to climate change by ensuring that all new network components (for example, planned pipe renewals, or upgrades in specific locations) are designed to a 1 in 10 yr ARI level of service, using conservative design storms that incorporate projected changes in rainfall intensity, coupled with conservative tidal boundary conditions. This is consistent with DCC's Code of Subdivision and Development, and also with the Building Act.

Currently 67 % of the modelled network in the catchment can accept stormwater during a 1 in 10 yr ARI rainfall without causing manhole overflows; however the majority of the pipes (80 %) are highly surcharged. Based on the age of the network, the pipes in the Port Chalmers catchment will be prioritised for assessment under the DCC pipe renewals programme; 83 % of the network is currently overdue for renewal but there is some uncertainty regarding this data (refer Section 4.7.2). Notwithstanding the uncertainty regarding the data, by 2060, 83 % of the pipes in the network (including some already at the desired level of service) will still have been assessed under the pipes renewal programme. The condition of the pipes will have been established and either had their life expectancy increased, or will have been replaced (with new pipes designed to convey the 1 in 10 yr ARI rainfall event). Whilst it is unlikely that the percentage of pipes to be renewed will be as high as 83 % (based on age and condition), the renewals programme will still provide an opportunity to improve the level of service within the catchment.



### 11.1.3 Low Level of Service

The current level of service in some parts of the catchment is below DCC's target for new infrastructure, primarily as a result of inadequate network capacity, with some minor tidal influence. The model predicts that 67 % of the network has the ability to accept rainfall from a 1 in 10 yr ARI event during MHWS tide conditions. This issue has been prioritised as 'manage passively' as the adverse effects predicted to result from the level of service are not considered to be significant.

The recommended targets and approaches with respect to the stormwater network performance focus on improving the existing level of service under current and future development and climate change scenarios. The strategic direction provided by the 3 Waters Strategic Direction Statement indicates that the main objective with respect to flooding is to ensure that the risk of flooding does not increase in the future as development occurs, or as climate change alters weather patterns and sea levels.

In general, DCC will adopt a long term approach to improving network performance and adapting to climate change by ensuring that all new network components (for example, planned pipe renewals, or upgrades in specific locations) are designed to a 1 in 10 yr ARI level of service, using conservative design storms that incorporate projected changes in rainfall intensity, coupled with conservative tidal boundary conditions. This is consistent with DCC's Code of Subdivision and Development, and also with the Building Act.

Historical data collection methods used for logging customer complaints have resulted in variable information on complaints. Improvements in complaints recording will result in a clearer picture of customer satisfaction in the future. The residents' opinion survey (ROS) has been running in its current format since 2003, and gauges Dunedin City residents' overall satisfaction with the stormwater collection service, amongst other council services. The Port Chalmers catchment lies within the Port Chalmers group of this survey. The results of the 2010 survey indicate that 71 % of respondents were either 'very satisfied' or 'satisfied' with the stormwater collection service.

### 11.1.4 Flood Hazard – Current and Future 1 in 100 yr ARI

Flood hazard is present in the Port Chalmers catchment as a result of flood extents and in some locations deep flooding. In large events (e.g. 1 in 100 yr ARI rainfall events), flood hazard affects transport corridors (including State Highways), commercial and residential areas of the catchment.

As the flood hazard is predicted to be occurring currently, the recommended targets have been established to ensure that adequate emergency response measure are developed for the catchment to ensure public health and safety in a low frequency event.

As the flood hazard is predicted to increase in the future, under the extreme climate change scenario (2060), it is appropriate that the potential effects of climate change on this catchment be considered by DCC's Climate Change Adaptation Plan (currently being developed).



### 11.1.5 Deep Flooding

The Building Act requires that habitable floors (or 'useful floor space' in relation to non-residential properties) should not be at risk of flooding during a 1 in 50 year rainfall event. The model predicts that four land parcels in the Port Chalmers catchment are estimated to be currently at risk of flood depths exceeding 300 mm during a current 1 in 10 yr ARI rainfall event, rising to nine during a 1 in 50 yr ARI rainfall event. Deep flooding predicted during the current 1 in 100 yr ARI rainfall event is estimated to increase the depth and extent of flooding in already identified flood areas, frequently in conjunction with 'significant' or 'extreme' flood hazard ratings. However, no increase in the number of land parcels affected is predicted.

Targets for this particular issue seek to avoid habitable floor flooding under both current and future land use and climate change scenarios. It is also desirable to avoid any increases in surface flooding of private properties during this event.

'Land parcels' and 'properties' are both used to provide information in this context, however model results only provide information in terms of 'land parcels'. DCC's targets are focused on avoiding habitable floor, or significant private property flooding, therefore actual numbers of properties / premises at risk is likely to be less than the number of land parcels reported.

The modelled flood extents and analysis of aerial photographs do indicate that flooding is unlikely to enter buildings. This has been verified in some cases by workshop discussions and review of flood complaints records. There are no known instances where buildings have experienced flooding in this catchment in the past.

Because the modelled flood extents and analysis indicate that in the majority of cases flooding may not actually enter buildings this issue has been prioritised as 'manage passively'.



Table 11-1: Port Chalmers Catchment Management Targets: Stormwater Quantity

| Issue (Problem Description) | Effects Summary                                                                                                                                                                                                                                                                                                                                                                             | Strategic Objectives and Targets                                                                                                                                                                                                         | Catchment Specific Approach                                                                                                                                                                                                                                                                                                                  | SMART Targets                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Network Maintenance         | <p>Flooding extents and durations in Port Chalmers catchment are potentially exacerbated by variations in the frequency and standards of catchpit cleaning and maintenance.</p> <p>City-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service.</p>                      | <p>Maintain key levels of service into the future by adapting to climate change and fluctuations in population, while meeting all other objectives.</p> <p>&gt; 60 % residents' satisfaction with the stormwater collection service.</p> | <p><b>Manage Passively</b></p> <p>Ensure consistency city-wide of stormwater structure cleaning and maintenance.</p> <p>Ensure cleaning and maintenance schedules and contracts are sufficiently robust.</p> <p>Identify areas in catchment where more regular stormwater structure cleaning and maintenance could reduce flooding risk.</p> | <p>Document cleaning and maintenance responsibilities for all stormwater inlet assets (city-wide).</p> <p>Develop consistent cleaning and maintenance criteria for all stormwater inlet assets (city-wide) by 2012.</p> <p>Develop list of key stormwater assets in Port Chalmers catchment requiring additional cleaning and maintenance checks by 2013.</p> |
| Nuisance Flooding           | <p>Nuisance flooding is predicted on a regular basis in a number of locations due to limited network capacity and restrictions throughout the catchment. Flooding is not significant during small events but becomes progressively worse with larger events.</p> <p>Affects 0.04 % of catchment area during 1 in 2 yr ARI events, and 0.7 % of catchment during a 1 in 10 yr ARI event.</p> | <p>Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network.</p>                                                                                                                     | <p><b>Manage Passively</b></p> <p>Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances).</p> <p>Undertake pipe renewals programme as scheduled (with older pipes and poorly performing network areas prioritised).</p>                                                              | <p>&lt; 33 % manholes predicted to overflow during a 1 in 10 yr ARI rainfall event by 2060.</p> <p>&lt; 0.7 % of catchment surface predicted to flood during a 1 in 10 yr ARI rainfall event by 2060.</p>                                                                                                                                                     |



| Issue (Problem Description) | Effects Summary                                                                                                                                                                                                                                                                                                                                                                                     | Strategic Objectives and Targets                                                                                                                                                                                                                                                                                                                                                                                                                                  | Catchment Specific Approach                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | SMART Targets                                                                                                                                                           |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Low Level of Service        | <p>General low level of service of stormwater network (less than 1 in 10 yr ARI), driven predominantly by network capacity.</p> <p>33 % of manholes predicted to overflow during a current 1 in 10 yr ARI rainfall event, with pipes flowing full throughout a large proportion of system.</p> <p>This low level of service is currently occurring with no capacity for climate change effects.</p> | <p>Maintain key levels of service into the future by adapting to climate change and fluctuations in population, while meeting all other objectives.</p> <p>Ensure new development provides a 1 in 10 year level of service for stormwater, and avoids habitable floor flooding during a 1 in 50 yr ARI rainfall event.</p> <p>95 % of customer emergency response times met.</p> <p>&gt; 60 % residents' satisfaction with the stormwater collection service.</p> | <p><b>Manage Passively</b></p> <p>Maintain or improve existing level of service in network – ensure no increase in the number of stormwater manholes predicted to overflow in a 1 in 10 yr ARI rainfall event.</p> <p>Design new pipes with capacity to convey a 1 in 10 yr ARI rainfall event (including climate change allowances).</p> <p>Undertake pipe renewals programme as scheduled (with older pipes prioritised).</p> <p>Use customer complaints and ROS to gauge satisfaction with the stormwater system performance.</p> | <p>&gt; 20 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060.</p> <p>&gt; 60 % residents' satisfaction with the stormwater collection service (ongoing).</p> |



| Issue (Problem Description)                                | Effects Summary                                                                                                                                                                                                                                                                                                                                  | Strategic Objectives and Targets                                                                                                                                                                                                                                                        | Catchment Specific Approach                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | SMART Targets                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Flood Hazard –<br>Current and<br>Future<br>1 in 100 yr ARI | <p>Areas of 'moderate' to 'significant' flood hazard in roadways, including State Highway predicted during current event.</p> <p>'Moderate' to 'significant' flood hazard extent predicted in the future (2060) event.</p>                                                                                                                       | Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network.                                                                                                                                                                           | <p><b>Manage Passively</b></p> <p>Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event.</p> <p>Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas.</p> <p>Ensure transport routes around flooding areas will be available.</p> <p>Develop a better understanding of the likely effects and magnitude of climate change.</p> | Provide modelled flood predictions to DCC Climate Change Adaptation Group to ensure information is taken into account during the development of a city-wide climate change adaptation plan.                                                                                                        |
| Deep Flooding                                              | <p>Model results indicate 4 land parcels affected by deep flooding during 1 in 10 yr ARI rainfall event; rises to 9 parcels during 1 in 50 yr ARI rainfall event in current and 12 parcels in future planning scenarios.</p> <p>A proportion of the deep flooding predicted during high frequency events is predicted exterior to buildings.</p> | <p>Ensure new development provides a 1 in 10 year level of service for stormwater, and avoids habitable floor flooding during a 1 in 50 yr ARI rainfall event.</p> <p>Ensure there will be no increase in the number of properties at risk of flooding from the stormwater network.</p> | <p><b>Manage Passively</b></p> <p>Ensure new development does not increase potential habitable floor flooding due to the stormwater system in events up to a 1 in 50 yr ARI rainfall event.</p> <p>Enhance understanding of effects of deep flooding, particularly on private property.</p> <p>Undertake pipe renewals programme as scheduled (with older pipes prioritised).</p>                                                                                                                                                                                                                          | <p>&lt; 9 properties at risk of deep flooding (&gt; 300 mm) during a 1 in 50 yr ARI rainfall event by 2060.</p> <p>Undertake habitable floor survey and / or damage assessment of potentially flooded properties.</p> <p>&gt; 20 % of pipes to convey a 1 in 10 yr ARI rainfall event by 2060.</p> |



## 11.2 Stormwater Quality Targets and Approaches

A summary of key stormwater quality effects, and catchment specific approaches and targets set for Port Chalmers catchment are presented in Table 11-2. The catchment specific approaches and targets are discussed in further detail below.

Whilst the monitoring information to date does not suggest that the stormwater quality from the Port Chalmers catchment is adversely affecting the marine environment, approaches and targets set out below describe a city-wide approach to stormwater quality as the Otago Harbour is a common receiving environment for all DCC coastal stormwater discharges.

It should be noted that the Regional Plan: Coast for Otago (ORC, 2009) sets out objectives and policies relating to discharges to the CMA. Objective 10.3.1 seeks *“to maintain existing water quality within Otago’s coastal marine area and to seek to achieve water quality within the coastal marine area that is, at a minimum, suitable for contact recreation and the eating of shellfish within 10 years of the date of approval of this plan”*.

Further, Policy 10.4.3 states that where water quality already exceeds these standards, water quality should not be degraded beyond the limits of a mixing zone associated with each discharge.

### 11.2.1 Limited Confidence in the Knowledge of Effects on the Otago Harbour Environment and Variability of Stormwater Quality Results

There is high variability in stormwater quality monitoring results from each catchment. Whilst stormwater quality is influenced by many variables and it is not unusual to see a wide range of contaminant levels in monitoring results, it is considered that this issue is compounded by the current monitoring technique of obtaining single annual grab samples of stormwater for analysis. The differing results between the annual grab-samples and single time-proportional sample from this catchment highlight this issue.

The Port Chalmers catchment does not have any requirements for sediment monitoring. However, in the majority of catchments, four annual cycles of sediment monitoring have been carried out to date (2007 to 2010) to determine the quality of the marine sediments. Sampling across the catchments has indicated that there are some contaminants of concern within the harbour, measured at relatively high levels. However, it remains unclear whether the contaminant levels observed are as a result of historic contamination or current discharges (from either stormwater or other sources). For this reason the sources of contamination are difficult to identify, as are any links with the quality of DCC stormwater discharges.

Slightly elevated concentrations in sediments sampled adjacent to the Port Chalmers catchment have been measured for certain contaminants, notably lead, PAHs and arsenic. However, only one year data set exists to date. These contaminants were not found to be significantly elevated in any of the stormwater discharges from the catchment, so contamination of the sediment could be attributed to sources outside of the Port Chalmers catchment.

There is little biological data for the Port Chalmers catchment and as such the health of the ecological communities remains inconclusive. Harbour-wide, the biological monitoring undertaken to date does not show any particular trends in diversity or abundance of fauna. The biological monitoring protocol is also highly variable between the catchments and not all catchments are monitored. With only four years of biological monitoring data that does not appear to be showing any trends, the variation in sampling protocols throughout the harbour and an absence of ecological baseline or control data for the harbour, it is difficult to draw conclusions from the biological monitoring results.



The monitoring regime to date has been insufficiently robust to enable the identification of any effects or otherwise, with any level of confidence, between stormwater quality and harbour environment health. In order to clearly identify discharges / catchments of concern and select appropriate stormwater management on a catchment by catchment basis to enable DCC to maintain or improve stormwater quality, a suitable monitoring framework, and improved confidence in monitoring data is required.

As indicated above and in the AEE, the monitoring information to date does not suggest that the stormwater quality from the Port Chalmers catchment is adversely affecting the marine environment, however contamination may have occurred in the past. Therefore targets and approaches outlined in this section relate to city-wide concerns, rather than catchment specific ones.

DCC have a commitment to improve the quality of stormwater discharges to the harbour and, in order to identify necessary and appropriate stormwater management actions within the catchment and city-wide, a sound understanding of the nature and effects of the stormwater discharge is required.

The approach and targets set for this issue include a staged approach that seeks to adjust the current monitoring programme in order to develop and implement an optimised monitoring framework that will provide more comprehensive and defensible information on current stormwater discharge quality and the effects thereof. Following this, it is expected that stormwater management approaches will be reviewed and adjusted to reflect DCC's strategic objectives. The recommended targets are as follows:

- Redesign the monitoring programme to develop a robust framework that will yield good quality, useful data at appropriate sites to enable a sound understanding of both catchment stormwater quality and health of the harbour environment and allow any linkages between the two to be identified.
- Using the monitoring results and other available information (such as land use), identify with confidence, discharges/catchments of concern and potential sources of unacceptable contaminant levels.
- Enable specific city-wide, targeted annual monitoring protocol to be established where necessary, including quality indicators, which can be used to provide feedback on stormwater management practices, and trigger further action as required.
- Use data to contribute to the stormwater management programme for Dunedin. This will include the identification of stormwater management actions to improve stormwater quality where required and enable specific city-wide, targeted annual monitoring protocol to be established where necessary, including quality indicators, which can be used to trigger further action as required.

Due to the relatively low concentrations of contaminants measured in the stormwater discharged from the Port Chalmers catchment, it is unlikely that this catchment will be prioritised for immediate extensive monitoring.



In the interim, while catchment specific stormwater actions and targets are still being established, DCC are committed to looking for quick-win opportunities where point source contamination has been identified, and at a minimum, to ensuring that stormwater quality does not deteriorate as a result of new development or changes in land use in the catchment. Examples of this include:

- Considering the cost and benefit of incorporating stormwater treatment into flood mitigation works where practicable.
- Requiring source control or management of stormwater contaminants in high contaminant generating land uses by enforcing the Trade Waste Bylaw, and working to educate occupiers of high-risk sites with respect to stormwater discharge quality.
- The Dunedin Code of Subdivision and Development indicates that at-source management of stormwater quantity is desirable and Low Impact Design methods are preferred.

### 11.2.2 Ongoing Stormwater Discharge

The monitoring data at present indicates relatively low levels of contaminants in stormwater from the Port Chalmers catchment stormwater. The exception is relatively high microbial contamination on one occasion, which is addressed as a separate issue. Therefore based on the best available information at this time, the prioritisation of this issue has resulted in a 'passive management' approach.

However, it is acknowledged that there is low confidence in the current monitoring data; therefore, this issue is related to the above issue regarding limited confidence in the knowledge of effects on the harbour environment.

The approach and targets for this issue are related to the outcomes of the targets set for confidently identifying the levels of contaminants in the stormwater and any resulting effects on the harbour environment. Following the outcomes of the proposed monitoring and stormwater management prioritisation targets, the approach to stormwater management in this catchment will be revised and catchment specific targets, where appropriate, will be applied.

In the mean time, DCC is committed to ensuring that there is no deterioration in current stormwater discharges and reducing the contaminant levels within stormwater discharges over time through development controls, as described above.

### 11.2.3 Potential Wastewater Contamination

The stormwater monitoring results for the Port Chalmers catchment show microbial contaminant levels were above the upper level that is typical of urban stormwater in 2007. However FWA levels (an indicator of human wastewater contamination) were measured at their highest levels when microbial levels were measured at low levels.

There are no corresponding wastewater flooding complaints for this incident however there are known connections with the wastewater network in this catchment.

The elevated microbial levels measured in 2007 appear to be an isolated incident but the monitoring is insufficiently robust to confirm this. However, there is little evidence to suggest a significant problem with wastewater contamination of the stormwater in this catchment, and as such this issue has been prioritised for passive management.

However, it is acknowledged that there is low confidence in the current monitoring data. Therefore this issue is related to the issue below regarding ongoing stormwater discharge.



### 11.2.4 Wastewater Emergency Overflows

Two wastewater pump stations with emergency overflows to the stormwater network exist in this catchment. Frequency analysis has indicated that the operation of the overflows is unlikely unless there is a pump failure or a significant rainfall event ( $> 1$  in 50 yr ARI), and there are no known instances of either overflow operating in recent past. As such, the risk of contamination of the stormwater relatively low and as such this issue has been prioritised for passive management.

However, this issue presents a potential failure to meet DCC Strategic Objectives should the overflow operate due to capacity issues. Wastewater contamination of stormwater discharges is also a major stakeholder issue. The targets and approaches set for this issue therefore, are related to improving information on the risks and actual frequency of overflow operation in order to inform future management decisions.



Table 11-2: Port Chalmers Catchment Management Targets: Stormwater Quality

| Issue (Problem Description)                                                                                         | Effects Summary                                                                                                                                                                                                                                                                                   | Strategic Objectives and Targets                                                                                                                                                                                                                                                                                                                              | Catchment Specific Approach                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | SMART Targets                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Limited Confidence in the Knowledge of Effects on Harbour Environment and Variability of Stormwater Quality Results | <p>High variability of stormwater quality results, any trends in stormwater contaminant levels remain unclear.</p> <p>Poor information on actual effects of stormwater on harbour environment.</p> <p>Lack of data to assess linkages between pipe discharge and harbour environment quality.</p> | <p>Improve the quality of stormwater discharges to minimise the impact on the environment.</p> <p>Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges.</p> <p>No recorded breaches of the RMA.</p> <p>Ensure stormwater discharge quality does not deteriorate.</p> | <p><b>Manage Actively</b></p> <p>Redesign DCC's monitoring programme to ensure stormwater quality and receiving environment data is collected within a robust framework.</p> <p>Develop method for determining linkages between stormwater management and harbour environment.</p> <p>Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable.</p> <p>Require source control of stormwater contaminants in new development of high-contaminant generating land uses.</p> <p>Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality.</p> <p>Undertake monitoring to ensure stormwater quality does not deteriorate over time.</p> <p>Incorporate a feedback process to the ICMP if / when monitoring indicates potential adverse effects from stormwater discharges.</p> | <p>Robust city-wide monitoring framework developed and implemented by 2012.</p> <p>Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013.</p> <p>Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015.</p> |



| Issue (Problem Description)        | Effects Summary                                                                                                                                                                                                                     | Strategic Objectives and Targets                                                                                                                                                                                                                                                                                                                                                      | Catchment Specific Approach                                                                                                                                                                                                                                                                                                                                                                               | SMART Targets                                                                                                                                                                                                                 |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ongoing Stormwater Discharge       | <p>Could exacerbate existing / historical contaminant issues. Extent to which this is likely to occur is unconfirmed.</p> <p>Key stakeholder issue.</p> <p>Based on available data, consequence currently believed to be minor.</p> | <p>Improve the quality of stormwater discharges to minimise the impact on the environment.</p> <p>Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges.</p> <p>&gt; 75 % compliance with stormwater discharge consents.</p> <p>Ensure stormwater discharge quality does not deteriorate.</p> | <p><b>Manage Passively</b></p> <p>Consider the cost / benefit of stormwater quality treatment as part of flood mitigation works where practicable.</p> <p>Require source control of stormwater contaminants in new development of high-contaminant generating land uses.</p> <p>Enforce the Trade Waste Bylaw, and educate occupiers of high-risk sites with respect to stormwater discharge quality.</p> | <p>No deterioration of stormwater quality due to land use change or development in the catchment.</p> <p>Implement an education / enforcement programme targeting stormwater discharges from high risk land uses by 2015.</p> |
| Potential Wastewater Contamination | <p>High microbial contamination of stormwater in 2007, may be cause for concern.</p>                                                                                                                                                | <p>Improve the quality of stormwater discharges to minimise the impact on the environment.</p> <p>Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges.</p> <p>&gt; 75 % compliance with stormwater discharge consents.</p> <p>Ensure stormwater discharge quality does not deteriorate.</p> | <p><b>Manage Passively</b></p> <p>Continued stormwater monitoring to enable better understanding of potential catchment contamination.</p> <p>Investigate potential sources of wastewater contamination.</p> <p>Develop appropriate management options to remediate problem where necessary.</p>                                                                                                          | <p>Improve data relating to levels microbial contamination and potential sources of contamination within the catchment by 2012.</p> <p>Implement management options to remediate problem where necessary.</p>                 |

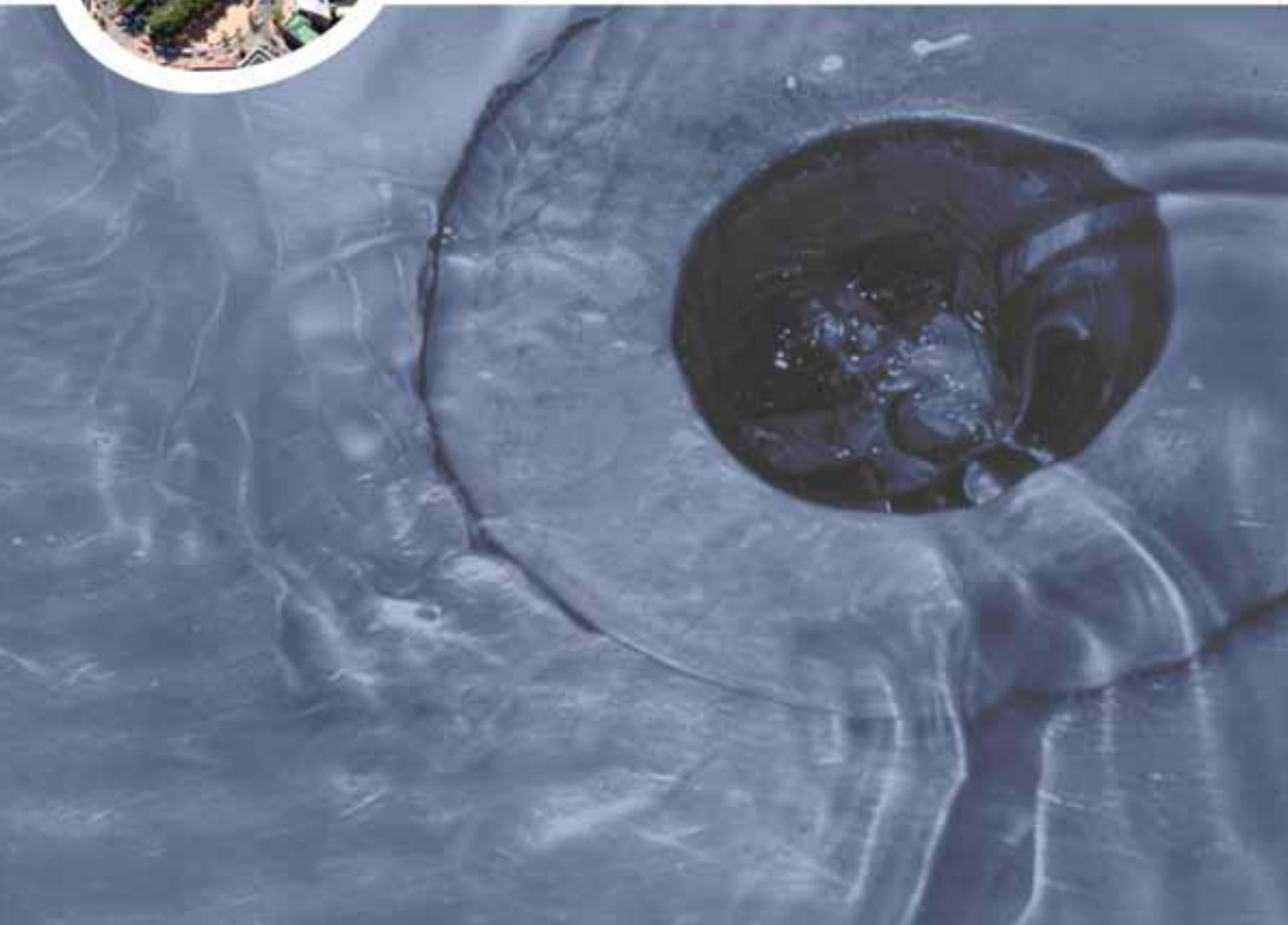


| Issue (Problem Description)    | Effects Summary                                                                                                                | Strategic Objectives and Targets                                                                                                                                                                                                                                                                         | Catchment Specific Approach                                                                                                                                                                                                                                       | SMART Targets                                                                                                                                                                                                                                                                                      |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wastewater Emergency Overflows | Potential for wastewater contamination of stormwater should overflows operate. Analysis to date suggests infrequent operation. | <p>Reduce the number of wastewater overflows arising as a result of capacity.</p> <p>Adopt an integrated approach to water management which embraces the concept of kaitiakitaka and improves the quality of stormwater discharges.</p> <p>Ensure stormwater discharge quality does not deteriorate.</p> | <p><b>Manage Passively</b></p> <p>Undertake monitoring to enable better understanding of frequency and cause of operation and risk of potential stormwater contamination.</p> <p>Develop appropriate management options to remediate problem where necessary.</p> | <p>No pump station overflows due to capacity during a 1 in 10 yr ARI rainfall event.</p> <p>Improve understanding of frequency and cause of operation and risk to stormwater quality by 2015.</p> <p>Develop management approaches and ongoing monitoring protocols by 2015 where appropriate.</p> |



## Part 5

### Solutions







## 12 Stormwater Management Options

### 12.1 Introduction

Options are presented to manage the stormwater issues identified in the Port Chalmers catchment. Options are generally capital work options, planning options, or operation and maintenance tasks. These have been developed in line with issues prioritisation and catchment specific targets and approaches set in Section 11.

When considering the options available for each issue, options considered to be 'deal breakers' are eliminated from the options to be evaluated. Example definitions of deal breakers are as follows:

- Option must be technically feasible;
- Option must meet relevant legislative requirements;
- Option must be consistent with the principles of the Treaty of Waitangi;
- Option must be aligned with the catchment specific objectives developed in Section 11 of this document;
- Option must not have greater negative environmental, social or cultural consequences than the 'do nothing' option;
- Option should not contravene any explicitly stated political objective;
- Option should not result in an increase in the risk category; and
- Option should not increase health and safety risks compared with the 'do nothing' option.

'Active management' indicates that DCC will seek to implement changes to stormwater management in the catchment, whereas 'passive management' would tend more towards monitoring and review of existing management practices to ensure that the targets set can be met. This section puts forward a number of options (where more than one exists) for each issue identified in the catchment.

Following the elimination of deal breakers, information on options for stormwater management is collated. The options identified for 'manage actively' issues are then evaluated against the QBL evaluation criteria outlined in Section 14, with the most favourable stormwater management option identified.

Following the identification of options for each stormwater management issue, and options evaluation using QBL methodology, a prioritised programme of capital works and additional investigations recommended in the Port Chalmers catchment is then developed.

The implementation of the programme is expected to progressively improve stormwater management in the catchment as part of the wider 3 Waters Strategic Plan, which incorporates programming of the outcomes recommended in all ICMPs developed across the city.



## 12.2 Potential Options

Outlined below are preliminary options identified for the key stormwater management issues present in the catchment. Option 'deal breakers' are eliminated and feasible options are described in further detail.

Where an issue has been prioritised as 'manage passively', management options are discussed in more general terms, although planning based options may be presented where applicable.

Where an issue is prioritised as 'manage actively', where available, a number of alternative options may be considered for further evaluation in Section 14, if more than one potential solution is available.

### 12.2.1 Low Level of Service – Manage Passively

The current level of service in some parts of the catchment is below DCC's target for new infrastructure, as a result of both tidal influence and inadequate network capacity, with 67 % of the network predicted to have the ability to accept rainfall from a 1 in 10 yr ARI event during MHWS tide conditions. In those areas where the network capacity is less, some nuisance effects are predicted to occur; management options for these effects are addressed under the 'nuisance flooding' issue. The results of the ROS indicates that residents / building owners are not dissatisfied with the current level of service provided. This, combined with the fact that the dominant result of the low level of service is nuisance flooding, sets the management of this issue as passive.

The catchment specific approach for this issue includes the following:

- Maintain or improve existing level of service in network – ensure no increase in the number of manholes predicted to overflow in a 1 in 10 yr ARI rainfall event.
- Design new pipes with capacity to convey a 1 in 10 year storm event.
- Undertake pipe renewals programme from 2012.
- Ensure new development does not increase potential habitable floor flooding in events up to a 1 in 50 yr ARI rainfall event.
- Use customer complaints and ROS to gauge satisfaction with the stormwater system performance.

The 'Dunedin Code of Subdivision and Development' is used by DCC to set requirements for land development and subdivision, but is also used by DCC to guide design of network upgrades undertaken by DCC. Table 12-1 outlines the design criteria required by DCC for new stormwater work. Compliance with this document ensures that the approach to design new pipes to convey a 1 in 10 yr ARI rainfall event is met, and that secondary protection is provided up to a 1 in 100 yr ARI rainfall event.

As development occurs, or pipe renewals are undertaken, the level of service of parts of the network will gradually improve. Under DCC's pipe renewals programme, 83 % of the pipes in the catchment are due for investigation and / or renewal within the planning period of this document, based on the presumed age of installation. Although there is uncertainty regarding pipe age (refer Section 4.7.2), the pipe renewal process will include inspection and condition assessment, and potentially extends the useful life of a stormwater asset beyond 100 years, if it is in good condition. Where there are capacity issues, the renewals programme could be combined with pipe upgrades.



There is minimal tidal influence on parts of the Port Chalmers catchment stormwater network and as such levels of service may improve significantly via local upgrades as part of the pipe renewal process in certain locations. However, options investigated to resolve flooding, in conjunction with the renewals process, are likely to result in the improvements in system performance.

In the interim, the ROS can be used to gauge satisfaction with the stormwater system performance. The ROS provides a city-wide impression of satisfaction with the stormwater system, and is used to measure progress against a target of 60 % satisfaction. The Port Chalmers catchment is most aligned with the Port Chalmers group surveyed. In 2010 71 % of residents in the Port Chalmers area were either very satisfied or satisfied with the stormwater collection service. This is higher than the DCC target for satisfaction. Since the survey began in 2003, city-wide satisfaction with the stormwater collection service has been above 60 % in every year except 2004 / 2005 (Research First, 2010).

**Table 12-1: Stormwater Design Criteria**

| Function                                                                                                 | AEP % | Return Period (ARI, years) |
|----------------------------------------------------------------------------------------------------------|-------|----------------------------|
| Primary protection                                                                                       | 10    | 10                         |
| Primary protection in areas where secondary flow paths are not available or are through private property | 1     | 100                        |
| Secondary protection                                                                                     | 1     | 100                        |

### 12.2.2 Nuisance Flooding – Manage Actively

The strategic direction provided by the 3 Waters Strategic Direction Statement indicates that the main objective with respect to flooding is to ensure that the risk of flooding from the stormwater system does not increase in the future as development occurs, or climate change alters weather patterns and sea levels. Because the existing network has minimal capacity for increased flows, and the effects of future flooding are predominantly driven by climate change, the climate change adaptation plan will be needed to guide any flood mitigation options in this catchment.

Rules set for future development in DCC's Code of Subdivision and Development will ensure that into the future, new or re-development of sites will include the provision of stormwater detention and conveyance up to a 1 in 10 yr ARI rainfall event. It is likely that this, along with planned pipe renewals, will somewhat relieve the frequent nuisance flooding in the catchment in the long term.

Works to address the 83 % of the pipes in this catchment that are overdue for renewal, including inspection and condition assessment will be carried out. Whilst a percentage of the pipes are unlikely to be as old as data suggests, the renewals process will result in the replacement (and upgrade to meet current design standards) of some of the pipes in the catchment. As a minimum, new information relating to pipe age will be gathered and the targets for progressive upgrade of the catchment reviewed.



### 12.2.3 Deep Flooding – Manage Passively

A small number of land parcels in the Port Chalmers catchment are predicted to experience flood depths of greater than 300 mm during the current 1 in 10 yr ARI rainfall event combined with a MHWS tide; four parcels affected during a 1 in 10 yr ARI rainfall event, rising to nine during the 1 in 50 yr and 1 in 100 yr ARI rainfall events under current planning scenarios. Desk-top analysis of the model results indicates that it is unlikely that there is a risk to habitable floors during the current planning scenarios.

With the application of growth and mean climate change projections, it is predicted that the number of land parcels experiencing deep flooding will rise to 12 during a 1 in 50 yr ARI rainfall event and there may be a risk to habitable floors.

DCC's target with respect to potential habitable floor flooding is to ensure that the current risk is minimised during high frequency events, and is not increased in the future as development occurs and climate change is taken into account. Management of the effects of new development, therefore, would be as per the requirements of DCC's Code of Subdivision and Development (refer Section 12.2.1 for a discussion on this regarding levels of service).

In order to fully understand the risk of habitable floor / useful space flooding properties identified as being at risk will require building footprint confirmation and floor level survey to determine whether flood depths of 300 mm or greater would in fact enter the building. A damage assessment of affected properties which are commercial or industrial in nature is often useful in terms of identifying vulnerable premises.

### 12.2.4 Flood Hazard (Current and Future 1 in 100 yr ARI) – Manage Passively

During a current 1 in 100 yr ARI rainfall event, with MHWS tide, flooding is predicted to cover approximately 2.4 % of the catchment and flood hazard risk is predicted to be moderate to significant in some of locations. However, the majority of the flood extent and risk is concentrated within the road.

During the extreme future scenario consisting of a 1 in 100 yr ARI rainfall event combined with a 2060 tide (including climate change impacts) and a 1 in 20 yr ARI storm surge, flooding is predicted to cover approximately 6 % of the catchment. The flood hazard risk is predicted to remain moderate to significant and flood extents remain predominantly within the road. However some roads may be rendered impassable. The effects during this future scenario are as a result of climate change projections.

Small benefits may be gained, during current and future (extreme) events, from other management approaches seeking to improve network capacity. The catchment specific targets and approaches identified for this issue are as follows:

- Ensure new development does not increase the number of properties predicted to flood due to the stormwater system in a 1 in 100 yr ARI rainfall event.
- Protect key and vulnerable infrastructure (e.g. pump stations, works depots, schools, hospitals, electricity supply etc) from flood hazard. Avoid development of vulnerable sites / critical infrastructure in flood prone areas.
- Ensure transport routes around flooding areas are available.
- Develop a better understanding of the likely effects and magnitude of climate change.



In terms of ensuring that development does not further exacerbate flooding, management of the effects of new development would be as per the requirements of DCC's Code of Subdivision and Development (refer to Section 12.2.2 for a discussion on this regarding levels of service). Roads are not predicted to be fully inundated so it is not proposed to put any emergency response in place with respect to transport routes.

Flooding and flood hazard extents in this catchment are predicted to intensify in the future due to climate change impacts; therefore the management approach presented reflects this driver by ensuring that these effects are incorporated into climate change planning.

### **Develop Climate Change Adaptation Plan**

In order to develop a better understanding of the likely effects and magnitude of climate change, there needs to be an ongoing re-visitation of new information regarding climate change predictions, and the implications of these for the Port Chalmers catchment. The hydraulic model developed for this study would be a key tool in assessing the impacts of a range of further climate change scenarios. A climate change adaptation plan for the whole of Dunedin City would incorporate findings in terms of a plan for all catchments, including Port Chalmers. This plan may affect the options chosen in terms of on-going provision of level of service of the network. Damage assessment of critical and vulnerable sites (such as the State Highway and electricity substations) would form part of this work.

### **12.2.5 Network Maintenance – Manage Passively**

Flooding extents and durations in the Port Chalmers catchment could potentially be exacerbated should critical catchpits not be adequately cleaned.

Regular cleaning and maintenance of catchpits and stormwater structures is essential across the city, and city-wide inconsistencies in frequency and standards of cleaning and maintenance of stormwater structures (inlets and catchpits) can lead to discrepancies in level of service. The following catchment approaches have been developed for these issues:

- Ensure consistency city-wide of stormwater structure cleaning and maintenance.
- Ensure cleaning and maintenance schedules and contracts are sufficiently robust.

A review of schedules and methods used across the city could be undertaken to ensure that all possible contaminant sources (e.g. catchpits) are cleaned regularly, and the flood risk is reduced as much as possible. Alignment of contracts for this maintenance (currently with a number of agencies) would provide confidence that catchpit and stormwater structures were operating optimally.

As part of the contracts, key structures identified in each catchment management plan could be incorporated as requiring additional or more frequent attention. In the Port Chalmers catchment, the following structures would be included:

- George Street / Wickliffe Terrace Intersection – Catchpits.



### 12.2.6 Limited Confidence in the Knowledge of Effects on the Otago Harbour Environment and Variability of Stormwater Quality Results – Manage Actively

The annual stormwater quality monitoring results from the Port Chalmers catchment are variable but do not indicate high levels of many contaminants (with the exception of microbial contamination which is discussed further below). Whilst the sediment monitoring results indicate slightly elevated levels of certain contaminants, it cannot be concluded that this is a result of stormwater quality discharged from this catchment.

In general, the stormwater and harbour environment monitoring regime to date has been insufficiently robust to enable the identification of any relationship between stormwater quality and harbour environment health.

In order to clearly identify discharges / catchments of concern and select appropriate stormwater management on a catchment by catchment basis to enable DCC to meet their objectives regarding stormwater quality, a suitable monitoring framework, and a high confidence in monitoring data is required. The catchment specific approaches recommended for this issue in the Port Chalmers catchment (and city-wide) are:

- Redesign the monitoring programme to develop a robust framework that will yield good quality, useful data at appropriate sites to enable a sound understanding of both catchment stormwater quality and health of the harbour environment and allow any linkages between the two to be identified.
- Using the monitoring results and other available information (such as land use), identify with confidence, discharges/catchments of concern and potential sources of unacceptable contaminant levels.
- Enable specific city-wide, targeted annual monitoring protocol to be established where necessary, including quality indicators, which can be used to provide feedback on stormwater management practices, and trigger further action as required.
- Use data to contribute to the stormwater management programme for Dunedin. This will include the identification of stormwater management actions to improve stormwater quality where required.
- Considering the cost and benefit of incorporating stormwater treatment into flood mitigation works where practicable.
- Requiring source control or management of stormwater contaminants in high contaminant generating land uses by enforcing the Trade Waste Bylaw, and working to educate occupiers of high-risk sites with respect to stormwater discharge quality.

Due to the importance of this information in developing stormwater management options for stormwater quality (where required), the SMART targets identified for this issue seek to obtain and analyse information as quickly as possible. The primary target is as follows:

- Develop and implement a robust monitoring framework by 2012.

The approach and targets recommended include a staged approach that seeks to redesign the current monitoring framework to ensure that it will provide more comprehensive and defensible information on current stormwater discharge quality and the effects thereof. Following this, stormwater management approaches will be reviewed and adjusted where necessary to reflect



DCC's strategic objectives. Depending on the extent of the monitoring programme developed, monitoring may be prioritised. However, based on the time-proportional results obtained for this catchment, it is not recommended that this catchment be prioritised for immediate further monitoring.

Despite a 'manage actively' classification, the issue of undefined effects of stormwater on the harbour environment has led to the approach of resolving the issue via the development of a suitable monitoring framework. Consequently, only one option alternative is presented.

### **Design a Framework for Stormwater Quality and Harbour Environment Monitoring**

The augmentation of the current monitoring framework to result in the implementation of a more robust monitoring framework would allow the identification, with an improved level of confidence, of any effects or otherwise of stormwater quality on the sediment quality and harbour environment health. The monitoring framework should be re-designed to focus on the following outcomes:

- Improved confidence in stormwater quality data;
- Sound understanding of marine sediment quality, including the extent of historic contamination and rate of any ongoing contamination and potential sources;
- Identification of harbour biological health, using suitable indicators to attempt to 'single out' effects of stormwater discharges on the harbour environment;
- Identification of any links between pipe discharge and sediment quality, marine water quality, marine biology; and
- Identification of catchments / discharges of concern and associated stormwater contaminants of concern.

The results of the monitoring undertaken according to the revised framework will allow the following targets to be met:

- Improve confidence in data supporting analysis of stormwater discharge quality and effects on harbour environment, with improved confidence in data by 2013.

Use of data following the outcomes of the monitoring framework will be via the monitoring and continuous improvement of the ICMPs, as described in Section 17. The improved data confidence will allow the prioritisation of stormwater management recommendations based on the significance of stormwater quality issues. This would occur city-wide and form part of the 3 Waters Strategic Plan.

### **12.2.7 Ongoing Stormwater Discharge – Manage Passively**

The annual monitoring data at present indicates that the levels of many contaminants in stormwater from the Port Chalmers catchment are not significantly high (with the exception of microbial levels which are addressed in a separate issue). Therefore based on the best available information at this time, the prioritisation of this issue has resulted in a 'passive management' approach. Furthermore, the development and implementation of a robust stormwater quality monitoring framework, as outlined in Section 12.2.7 will mitigate the uncertainty in the stormwater quality data from this catchment.

Options for management of this issue are detailed below. They take into account the mixed land use of this catchment (residential, commercial and industrial). It is recommended that all options are applied.



The approach to stormwater quality management in this catchment will be revised following the outcomes of the proposed new monitoring framework. This will be implemented by updating the ICMP and the continuous monitoring and improving of SMART targets.

The management of stormwater discharges as new development occurs could be undertaken using several mechanisms:

- **Development Controls:** DCC have a preference for at-source management and low impact stormwater design as outlined in the draft Code of Subdivision and Development. This document also requires a minimisation of damage to the environment from adverse effects of stormwater runoff; that habitat requirements are taken into account; that stormwater treatment is put into place where practical and that road drainage applies appropriate stormwater treatment.
- **An amendment to the business processes used to manage subdivision and development.** This would be aimed at ensuring that the developer / DCC representative review the appropriate ICMP for the area of development, in order to direct stormwater treatment based on catchment specific requirements.
- **Trade Waste Bylaw:** The Trade Waste Bylaw currently includes standards for stormwater discharge quality. Enforcement of this Bylaw would result in an improved quality of stormwater discharge leaving industrial or commercial sites. The Bylaw currently includes standards for stormwater discharge relating to the ANZECC (2000) guidelines for Fresh and Marine quality. Following improved understanding of stormwater discharge quality and its effects, this Bylaw may require review.
- **Education and Assistance:** Also under the Trade Waste Bylaw, inspections of industrial premises could be undertaken to ensure that adequate on site management practices are being applied. Assistance could be provided by DCC to help achieve higher stormwater quality. It is anticipated that ORC would be involved in this type of scheme for consented discharges, and potentially have resources available to assist in city-wide education.

### 12.2.8 Potential Wastewater Contamination – Manage Passively

High levels of microbial contaminants were measured in the stormwater monitoring results from the Port Chalmers catchment in 2007, at levels higher than is typical for urban stormwater. There are no wastewater complaints records corresponding with this incident or known incidents of wastewater overflow operation at this time. The source of the contamination remains inconclusive and is likely to be an isolated incident. However, microbial contamination of stormwater is a key stakeholder issue and there is a risk of failure to meet DCCs Strategic objectives.

In order to enable DCC to maintain or improve stormwater quality, and implement appropriate management options to remediate any potential threat from microbial contamination a high confidence in monitoring data and identification of potential contaminant source(s) is required, which can be gained through further investigation into this issue.

The catchment specific approaches recommended for this issue in the Port Chalmers catchment are strongly related to those associated with the 'Ongoing Stormwater Discharge' issue. In addition, management approaches recommended to resolve known issues with the wastewater network in this catchment may also provide further information and / or eliminate any potential sources of wastewater contamination.



The catchment specific approaches are as follows:

- Improve data relating to levels microbial contamination and potential sources of microbial contamination within the catchment by 2012.
- Revise ICMPs to include new information, management approaches and ongoing monitoring protocols by 2014.

The approach to stormwater quality management in this catchment, relating to this issue will be revised following determination of the significance of this issue and identification of potential sources of contamination. This will be implemented by updating the ICMP and the continuous monitoring and improving of SMART targets.

It is proposed that the monitoring programme proposed under Section 12.2.7 be used to confirm (or otherwise) the presence of a wastewater discharge from the catchment.

### 12.2.9 Wastewater Emergency Overflows – Manage Passively

There are emergency overflows from the wastewater pump stations to the stormwater network at Mussel Bay and Mount Street in the Port Chalmers catchment. Wastewater investigations from Phase 2 of the 3 Waters project revealed that there are no known instances of the overflows operating in recent past and that any operation would only be triggered by pump failure or in severe rainfall events (> 1 in 50 yr ARI). As such the pump stations were not highlighted for further investigation in the wastewater Phase 2 outcomes.

Operation of the overflows may cause significant adverse effects to stormwater quality within the Port Chalmers catchment. It may result in breach of resource consent conditions, failure to meet DCC Strategic objectives and wastewater contamination of stormwater discharges is a significant stakeholder issue. However, the risk of both overflows operating is low and this has driven this issue to be prioritised as ‘manage passively’.

The catchment specific approaches for this issue relate to the low risk of overflow operation. Monitoring of overflow operation and any adverse effects thereof, will inform any further management options that may be required in the future to reduce the frequency of operation.

#### **Monitor Wastewater Pump Station Overflow Operation**

Monitoring and recording of the emergency overflows from the Mussel Bay and Mount Street wastewater pump stations could be used to provide further information on the frequency and effects of overflows.

Information recorded should include cause for overflows, size and duration of rainfall event and should include additional stormwater and receiving environment monitoring when the overflow is in operation and for a time period following an overflow. This would allow the effects to be assessed and further management options developed where appropriate.



## **13 Three Waters Integration**

### **13.1 General**

A key driver for the 3 Waters Strategy Project and indeed for the re-organisation of the DCC Water and Waste Business Unit, was to break down the “silo” based approach to the three waters and to encourage integration and efficiencies that can be gained by developing a holistic approach and understanding the inter-relationships and interactions between the three waters. Key advances in this respect relate to business systems integration; simultaneous and complementary modelling; use of identical growth and planning assumptions; and the consideration of integrated solutions.

Provided below is a summary of integration opportunities explored as part of this project, between stormwater and raw water / water supply and wastewater respectively. Reports relating to raw water, water supply, and wastewater studies undertaken as part of the 3 Waters Strategy Project are available from DCC upon request.

#### **13.1.1 Raw Water and Water Supply**

The key opportunity for integration between the water supply and stormwater systems is perhaps the need / potential for stormwater harvesting. Analysis of the water supply now and to the 2060 planning horizon indicates that generally the existing water sources will be adequate to meet future demand needs. The strategic water network and the reticulation are well placed to meet future demand and daily demand patterns. However, climate change predictions indicate that Dunedin will become drier for extended periods.

Population growth in Dunedin is relatively small and there is certainly potential to reduce leakage to counter the increased demand. Consequently, there is no need to encourage wide scale stormwater harvesting to meet system demand.

The suggested use of rain tanks is a frequent feature during public consultation. Whilst there are potential water quantity and quality benefits to the use of rain tanks, their widespread use has potential economic implications. Dunedin has adequate raw water sources to supply the city. Furthermore, the variable costs of treating water and wastewater are small when compared with fixed costs (including loans and depreciation). Consequently, any widespread initiatives to reduce water demand are likely to simply increase the unit cost for water and deliver little if any economic benefit to ratepayers. The environmental benefits of rain tanks, or any other demand management initiative need to be carefully balanced against the social and economic aspects of sustainability.

Leakage from the water supply can enter storm drains as infiltration. Whilst the amount of water entering the stormwater system is likely to be relatively small, any reduction in leakage will provide some limited benefit to the stormwater system through increasing the “headroom” by reducing the base flow in the pipes. This is a minor benefit however, and should not be considered as a main driver for leakage reduction or as a possible solution to stormwater system capacity shortfalls.

#### **13.1.2 Wastewater**

There are many ways in which stormwater can enter into the wastewater system and vice versa. Upgrade / capital works of the wastewater systems can lead to changes in the quantity and quality of stormwater discharge.



In Dunedin, the following issues influencing both wastewater and stormwater have been identified:

- I&I has been identified as a problem in number of wastewater catchments city-wide. I&I may be occurring from any location in the network, for example, from mains right up to private laterals. Stormwater can enter through manhole joints and covers, broken pipes or dislodged joints. A portion of the I&I may be due to cross connections between the stormwater and wastewater, a result of illegal connections, or old combined connections which are a legacy of the once combined system.
- There are known constructed wastewater emergency overflows which discharge wastewater to the stormwater system during wet weather. DCC state in the 3 Waters Strategic Direction Statement that they want to limit the use of these overflows in the short term with the long term target being total removal. As the overflows only occur in wet weather, if I&I can be limited in the first instance, the use of these overflows would reduce.

The success of any wastewater system rehabilitation and disconnection of cross connections will be dependent on the stormwater system having adequate capacity to take the additional flow.

The 3 Waters Strategy Project wastewater investigations did not identify any specific issues with the wastewater network within the Port Chalmers catchment.

A further opportunity for integrated solutions in this catchment between the wastewater and stormwater networks is likely to be in the co-ordination of the capital programme. This co-ordinated approach will be developed within the 3 Waters Strategic Plan.



## 14 Options Evaluation

### 14.1 Options Evaluation Criteria and Methodology

Options evaluation criteria have been developed based on objectives and decision making criteria set in the following:

- The 3 Waters Strategic Direction statement;
- DCC's Optimised Decision Making Matrix; and
- DCC's LTP.

Stormwater specific criteria have been developed for the QBL (economic, social, cultural and environmental) analysis, with an additional two risk categories, Implementation Risk and Effectiveness (risk reduction) separated from the core QBL by DCC and given significant weighting; the first to ensure that operationally, capital works installed will work, and the second to highlight the benefits of each option in terms of reduction of current risk and levels of service. The scoring framework is presented in Table 14-1. Weighting for each of the criteria has been assigned by DCC.

### 14.2 Options Comparison

For the Port Chalmers catchment there are a number of 'passive management' issues and only single options identified for higher priority issues and as such options comparison has not been necessary at the ICMP level. Comparison of recommendations for this catchment alongside other catchments will be undertaken as part of the 3 Waters Strategic Plan.



Table 14-1: Option Assessment Criteria and Scoring System

| QBL                   | Option Assessment Criteria                    | -10                                                                   | -5                                                                    | 0                                                                      | 5                                                                             | 10                                                                         |
|-----------------------|-----------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------------|-------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Environmental<br>(10) | Removal of known wastewater cross connections | Does not remove cross connection.                                     | Reduces likelihood of cross connection occurring.                     | Assists in finding unknown cross connections.                          | Removes cross connection for design events (emergency overflow still exists). | Removes cross connection under all events.                                 |
|                       | Contaminant reduction                         | None.                                                                 | 5 - 25 %                                                              | 25 - 40 %                                                              | 50 - 75 %                                                                     | 75 - 100 %                                                                 |
|                       | Use of source control / LID                   | No treatment or control.                                              | End of pipe treatment (catchment or sub-catchment based).             | Site based in-line treatment / collection of contaminant.              | LID with water reuse up to design event.                                      | Source control - avoid generation of contaminant of concern.               |
|                       | I&I reduction                                 | No I&I reduction possible.                                            | -                                                                     | -                                                                      | Minor I&I reduction possible without exacerbating stormwater flooding.        | Major I&I reduction possible without exacerbating stormwater flooding.     |
|                       | Construction effects                          | Major discharge of contaminants into environment during construction. | Minor discharge of contaminants into environment during construction. | -                                                                      | All contaminants generated contained on site and disposed of appropriately.   | No effects on environment - no contaminants generated during construction. |
|                       | Replication of current flow patterns          | No volumetric control.                                                | Minimal attenuation.                                                  | Replicates or reduces current flow patterns up to 1 in 2 yr ARI event. | Replicates or reduces current flow patterns up to 1 in 10 yr ARI event.       | Replicates or reduces current flow patterns up to a 1 in 100 yr ARI event. |
|                       | Option flexibility                            | Constrained.                                                          | Flexible for short term scenarios but cannot be staged.               | Will accommodate all scenarios but minimal staging.                    | Flexible for all but extreme scenarios and can be staged.                     | Flexible for all scenarios and can be staged.                              |



| QBL                      | Option Assessment Criteria                                                           | -10                                                                       | -5                                                           | 0                                                                     | 5                                                                      | 10                                                       |
|--------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------------|----------------------------------------------------------|
| Social (10)              | Interest / support of community / social interest groups                             | Major opposition from community / special interests groups.               | Some opposition from community / special interests groups.   | -                                                                     | Some support from community / special interests groups.                | Major support from community / special interests groups. |
| Cultural (10)            | Fit with Māori cultural values                                                       | Contradicts key cultural values.                                          | Unlikely to fit with values and preferred approaches.        | Not specifically identified as preferred approach, but likely to fit. | Fits with preferred approach recommended by local iwi.                 | Involves iwi in development and design of option.        |
| Implementation Risk (20) | Risk of operational failure                                                          | Likely operational failure. Unproven technology.                          | New technology. Extensive training required.                 | Moderately complicated new technology.                                | Minor modifications to technology already used. Simple new technology. | Proven technology, already utilised throughout city.     |
| Economic (10)            | Estimated Capital Cost - order of magnitude (note does not allow for internal costs) | \$ 10m+                                                                   | \$ 1 - \$ 10m                                                | \$ 500k - \$ 1m                                                       | < \$ 500k                                                              | Free                                                     |
|                          | Risk of cost escalation due to construction unknowns                                 | High - escalation likely as no alternatives and insufficient information. | Moderate risk. Low number of alternatives available.         | -                                                                     | Can be managed via alternatives.                                       | Low risk. Well known issue and design criteria.          |
|                          | Risk of land availability                                                            | Unlikely to secure land.                                                  | Long process for negotiation, or high cost of land expected. | Moderate process / costs anticipated.                                 | Unutilised land likely easy to secure.                                 | Land already owned by DCC.                               |
|                          | Risk of protracted consent process with authorities                                  | Consent unlikely.                                                         | High risk of long process.                                   | Medium consent process anticipated.                                   | Short consent process anticipated.                                     | No consent necessary.                                    |



| QBL                                       | Option Assessment Criteria                         | -10                                                                                     | -5                                                                                     | 0                                                                                                          | 5                                                                                                  | 10                                                                                                   |
|-------------------------------------------|----------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Effectiveness<br>(Risk Reduction)<br>(30) | Risk reduction                                     | Extreme risk reduced to very high; Very High reduced to high.                           | Extreme risk reduced to High.                                                          | Extreme or Very High risk reduced to Moderate; High risk reduced to Moderate or low.                       | Extreme or Very High risk reduced to Moderate; High risk reduced to Low or negligible.             | Extreme or Very High risk reduced to Low or negligible.                                              |
|                                           | Deep flooding 1 in 50 yr ARI future - current      | Increase in number of properties flooding in current scenario.                          | No change in number of properties predicted to flood, current or future.               | No change in properties flooding currently, reduction in future flooding.                                  | Number of properties predicted to flood in future scenario same as predicted for current scenario. | Number of properties predicted to flood in future scenario less than predicted for current scenario. |
|                                           | Manholes overflowing 1 in 10 yr ARI future-current | Increase in number of manholes overflowing in current scenario.                         | No change in number of manholes overflowing, current or future.                        | No change in number of manholes overflowing currently, reduction in future number of manholes overflowing. | Number of manholes overflowing in future scenario same as predicted for current scenario.          | Number of manholes overflowing in future scenario less than predicted for current scenario.          |
|                                           | Improvement in level of service                    | Significant reduction in perceived level of service, increase in % customer complaints. | Perceived level of service likely to decrease, some increase in % customer complaints. | No change to perceived level of service or % customer complaints.                                          | Minimal improvement to perceived level of service, some reduction in % customer complaints.        | Significant improvement to perceived level of service, large reduction in % customer complaints.     |



## 15 Option Selection

As comparison of alternative options was not undertaken for the Port Chalmers catchment, all options presented in this ICMP have been recommended.

### 15.1 Approaches for Active Management

The issue that has been prioritised in the Port Chalmers catchment as requiring 'active management' is identified below.

- Limited Confidence in Knowledge of Effects on Otago Harbour Environment and High Variability of Stormwater Quality results.

A comparison of options was not undertaken as they either involved non-infrastructure options or did not have any feasible alternative. The following option has been recommended in order to manage the above issue:

- Redesign and implement the city-wide framework for stormwater quality and harbour environment monitoring.

Improved data confidence will allow the prioritisation of stormwater management recommendations based on the significance of stormwater quality issues. This would occur city-wide and form part of the 3 Waters strategic plan.

### 15.2 Approaches for Passive Management

A number of other issues that have been prioritised as requiring 'passive' management will have targets achieved through measures already in place, or via the options identified for other issues in the catchment. The following options have also been identified to aid management of some of these issues:

- Ensure planned renewals are designed to accommodate a 1 in 10 yr ARI rainfall event, and incorporate allowances for climate change effects;
- Undertake pipe renewals programme from 2012;
- Ensure new development does not increase potential habitable floor flooding in events up to a 1 in 50 yr ARI rainfall event;
- Undertake a review of schedules and methods used across the city to maintain stormwater structures (catchpits and inlets);
- Incorporate catchpits at the George Street / Wickliffe Terrace intersection into a priority list for more regular catchment inspection and cleaning;
- An amendment to the business processes used to manage subdivision and development to direct stormwater treatment based on catchment specific requirements;
- Utilise stormwater complaints information and ROS to continuously gauge customer satisfaction with the stormwater service;
- Development of a climate change adaptation plan (city-wide);
- Continue to monitor microbial levels within stormwater from the catchment to confirm significance of issue; and



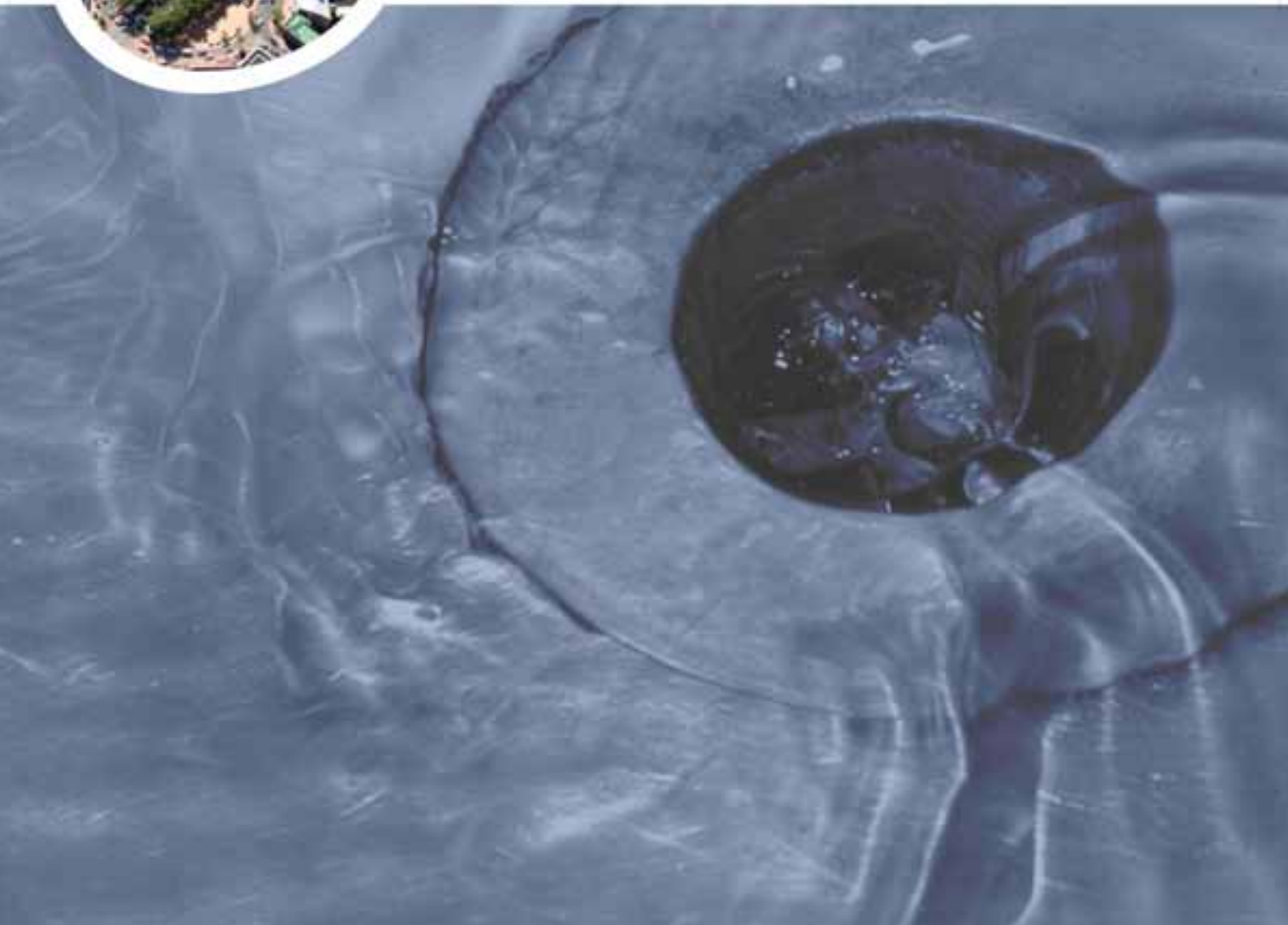
- Monitor wastewater emergency overflows and amend management approach as necessary.





## Part 6

### Way Forward







## 16 Recommendations

The following tables provide a list of recommendations relating to stormwater management in the Port Chalmers catchment, and provide an indicative cost and work period for each recommendation. The recommendations are listed in order of priority, relating predominantly to issue prioritisation. The intention is that as each task is carried out, the influence on catchment management targets is assessed, and further tasks are undertaken as necessary to achieve targets. Where a cost of \$ 0 has been applied, it is intended that DCC staff undertake the work. The recommendations will have their delivery dates set by the 3 Waters Strategic Plan, yet to be developed. Refer to Section 17 regarding implementation of the Plan.

Recommendations are split into further studies, planning and education, operation and maintenance, and capital works tasks. Further studies recommended will assist in improving certainty around catchment management targets, or where further information is required in order to develop options.

**Table 16-1: Further Study Recommendations**

| Risk Matrix Score | Task                                                                                                                                                     | Budget Cost | Work Period  |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|
| 160               | Redesign the city-wide framework for stormwater quality and harbour environment monitoring.                                                              | \$ 20 k     | 3 - 6 months |
| 40                | Utilise stormwater complaints and ROS information to continuously gauge customer satisfaction with the stormwater service.                               | \$ 0        | Ongoing      |
| 30                | Identify and undertake floor level survey and damage assessment of properties potentially internally affected by deep flooding (up to a 1 in 50 yr ARI). | \$ 20 k     | 3 - 6 months |

**Table 16-2: Planning and Education Recommendations**

| Risk Matrix Score | Task                                                                                                                                                                              | Budget Cost | Work Period   |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------------|
| 40                | Develop a city-wide climate change adaptation plan, including ongoing monitoring of climate change predictions, incorporating damage assessment of the vulnerable infrastructure. | \$ 0        | 6 - 12 months |
| 40                | Review business processes to ensure subdivision and development incorporates catchment specific requirements per the relevant ICMP.                                               | \$ 0        | 2 months      |



**Table 16-3: Operation and Maintenance Recommendations**

| Risk Matrix Score | Task                                                                                                                                                          | Budget Cost | Work Period  |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|
| 160               | Implement the revised city-wide monitoring framework.                                                                                                         | \$ 25 k     | Annual       |
| 50                | Compile an inventory of all stormwater structures including asset condition, ownership and identify key locations for more frequent cleaning and maintenance. | \$ 20 k     | 3 - 6 months |
| 50                | Undertake a city-wide review of all current contracts for maintenance of stormwater structures; documenting scope and standards.                              | \$ 20 k     | 2 months     |
| 40                | Ensure planned renewals are designed to accommodate a 1 in 10 yr ARI rainfall event and incorporate allowances for climate change.                            | 0           | Annual       |
| 20                | Implement programme to monitor wastewater emergency overflows.                                                                                                | \$ 25 k     | Annual       |



## 17 Implementation, Monitoring and Continuous Improvement of the ICMP

### 17.1 Implementation

As detailed in Section 1 of this report, there are a number of DCC documents linked to the outcomes of this ICMP. These include the Code of Subdivision and Development, the District Plan, and the 3 Waters Strategic Plan. A number of other documents are subsequently also influenced by this document.

The DCC 3 Waters Strategic Plan pulls together the recommendations from all ICMPs, as well as other 3 Waters work prepared by DCC. Currently, ten ICMPs are under development, and the recommended options presented by each ICMP will need to be managed in a coordinated manner. Targets set within each ICMP, and issue prioritisation will be used to determine the programme for commitment of staff resources, and both operational and capital funds for recommended works across the city over the coming years.

### 17.2 Monitoring and Continuous improvement

The continuous monitoring and reporting with respect to the SMART targets developed for each of the critical stormwater issues ensures that the success of this ICMP will be measurable.

Recommendations presented in Section 16 above have been prioritised, and provide the opportunity for DCC to progressively work towards these targets. It also ensures that when targets have been reached, DCC can re-evaluate recommended works appropriately.

The revision of the ICMP will be required at a number of milestones, and may either be minor updates or major changes as follows:

1. When the revised stormwater and harbour environment monitoring programme has been implemented and information collated and assessed to confirm any key stormwater quality issues requiring management;
2. Due to changes in climate change predictions; and
3. As monitoring data is collected and reviewed for trends. The monitoring framework developed for assessing the effects of stormwater discharges on the harbour environment will need to be refined as more information is learnt about the effects on the harbour, and key areas of concern.



## 18 References

- Australian and New Zealand Environment Conservation Council (2000). *Australia and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1: The Guidelines*. National Water Quality Management Strategy – Paper No. 4.
- Auckland Regional Council (2005). *Sources and loads of metals in urban stormwater*. Auckland Regional Council Technical Publication No ARC04104, based on report prepared for ARC by NIWA, June 2005.
- Bishop, D.G., Turnbull, I.M. (comp) (1996). *Geology of the Dunedin area*. Institute of Geological and Nuclear Sciences 1:250 000 geological map 21. Lower Hutt, New Zealand.
- Christchurch City Council (2003). *Waterways, Wetlands and Drainage Guide. Part B: Design*. Christchurch, New Zealand.
- Kāi Tahu ki Otago Ltd (2005). *Cultural Impact Assessment Discharges of Stormwater Otago Harbour and Second Beach*. Report prepared for DCC, October 2005.
- Metcalf & Eddy (1991). *Wastewater Engineering: Treatment, Disposal and Reuse*. 3<sup>rd</sup> Edition. McGraw Hill Education.
- Opus (2011a). *Port Chalmers Integrated Catchment Management Plan: Model Build Report*. Client report prepared for DCC.
- Opus (2011b). *Port Chalmers Integrated Catchment Management Plan: Catchment Hydraulic Performance Report*. Client report prepared for DCC.
- Otago Regional Council (1998). *Otago Harbour – An Investigation of Sediment in the Upper Harbour Basin and Andersons Bay Inlet*. Dunedin, New Zealand.
- Otago Regional Council (2009). *Regional Plan: Coast for Otago*. Dunedin, New Zealand.
- Probert (1990a). *Marine Environmental Implications of Proposed Extensions to Port Chalmers Container Terminal*. In: Port Otago Ltd Boiler Point Reclamation Environmental Impact Assessment. Prepared by Royds Garden, Consulting Engineers, March 1990.
- Probert (1990b). *Marine Environmental Implications of Proposed Extensions to the Reclamation of Observation Point, Port Chalmers*. In: Port Otago Ltd Observation Point Reclamation Environmental Impact Assessment. Prepared by Royds Garden, Consulting Engineers, June 1990.
- Research First (2010). *2010 Residents' Opinion Survey*. Client report prepared for Dunedin City Council, June 2010.
- Recycled Organics Unit (2007). *Recycled Organics Products in Stormwater Treatment Applications*. Second Edition. Sydney, Australia.
- Ryder Consulting Ltd. (2010a) *Ecological Assessment of Dunedin's Marine Stormwater Outfalls*. Client report prepared for Dunedin City Council, July 2010.
- Ryder Consulting (2010b). *Compliance Monitoring 2010. Stormwater Discharges from Dunedin City*. ORC Resource Consents 2002.080 – 2002.110 and 2006.222. Client report prepared for Dunedin City Council, July 2010.
- Ryder Consulting Ltd. (2010c). *Dunedin Three Waters Strategy Stream Assessments*. Client report prepared for Dunedin City Council, July 2010



- Ryder Consulting (2009). Compliance Monitoring 2009. Stormwater Discharges from Dunedin City. ORC Resource Consents 2002.080 – 2002.110 and 2006.222. Client report prepared for DCC, July 2009.
- Ryder Consulting (2008). Compliance Monitoring 2008. Stormwater Discharges from Dunedin City. ORC Resource Consents 2002.080 – 2002.110 and 2006.222. Client report prepared for DCC, July 2008.
- Ryder Consulting (2007). Compliance Monitoring 2007. Stormwater Discharges from Dunedin City. ORC Resource Consents yet to be granted. Client report prepared for DCC, July 2008.
- Ryder Consulting (2006). Remediation of Contaminated Sediments off the South Dunedin Stormwater Outfall: A proposed course of action. Client report prepared for DCC, December 2006.
- Ryder Consulting (2005a). Characterisation of Dunedin's Urban Stormwater Discharges & Their Effect on the Upper Harbour Basin Coastal Environment. Client report prepared for DCC, February 2005.
- Ryder Consulting Ltd. (2005b). *Spatial Distribution of Contaminants in Sediments off the South Dunedin Stormwater Outfall*. Client Report prepared for DCC, October 2005.
- URS (2008). *Dunedin 3 Waters Strategy, Stormwater Catchment Prioritisation Framework*. Client report prepared for DCC.
- URS (2009). *Dunedin Three Waters Strategy Phase 2 Stormwater Catchment Prioritisation Framework – Draft*. Report Prepared for Dunedin City Council, July 2009.
- URS (2011a). *Dunedin City Imperviousness, Dunedin 3 Waters Strategy*. 8 August 2011.
- URS (2011b). *Dunedin Integrated Catchment Management Plans: Rainfall and Tidal Analysis Report, Dunedin 3 Waters Strategy*. 8 August 2011.
- U.S Department of Transportation Federal Highway Administration (1990). *Pollutant loadings and impacts from highway stormwater runoff Volume 1: Design Procedure*.
- Van Valkenhoed, B, and Wright, A (2009). *Salt Water Intrusion Investigation November 2008 – February 2009*. Internal DCC report.
- Wendelborn, A., Mudde, G., Deletic, A., and Dillon, P. *Research on Metals in Stormwater for aquifer storage and recovery in alluvial aquifers in Melbourne, Australia*. ASMAR Aquifer Recharge 5<sup>th</sup> international symposium. 10-16 June 2005, Berlin.
- Williamson, R.B. (1993). *Urban Runoff Data Book. A Manual for the Preliminary evaluation of Urban Stormwater Impacts on Water Quality*. Water Quality Centre Publication No. 20.
- Zollhoefer, J (2008). *'Brookhaven wetland swale, Christchurch. Stormwater Analysis and Ecological Assessment'*. Technical report prepared for Christchurch City Council, Eliot Sinclair & Partners Limited, July 2008.